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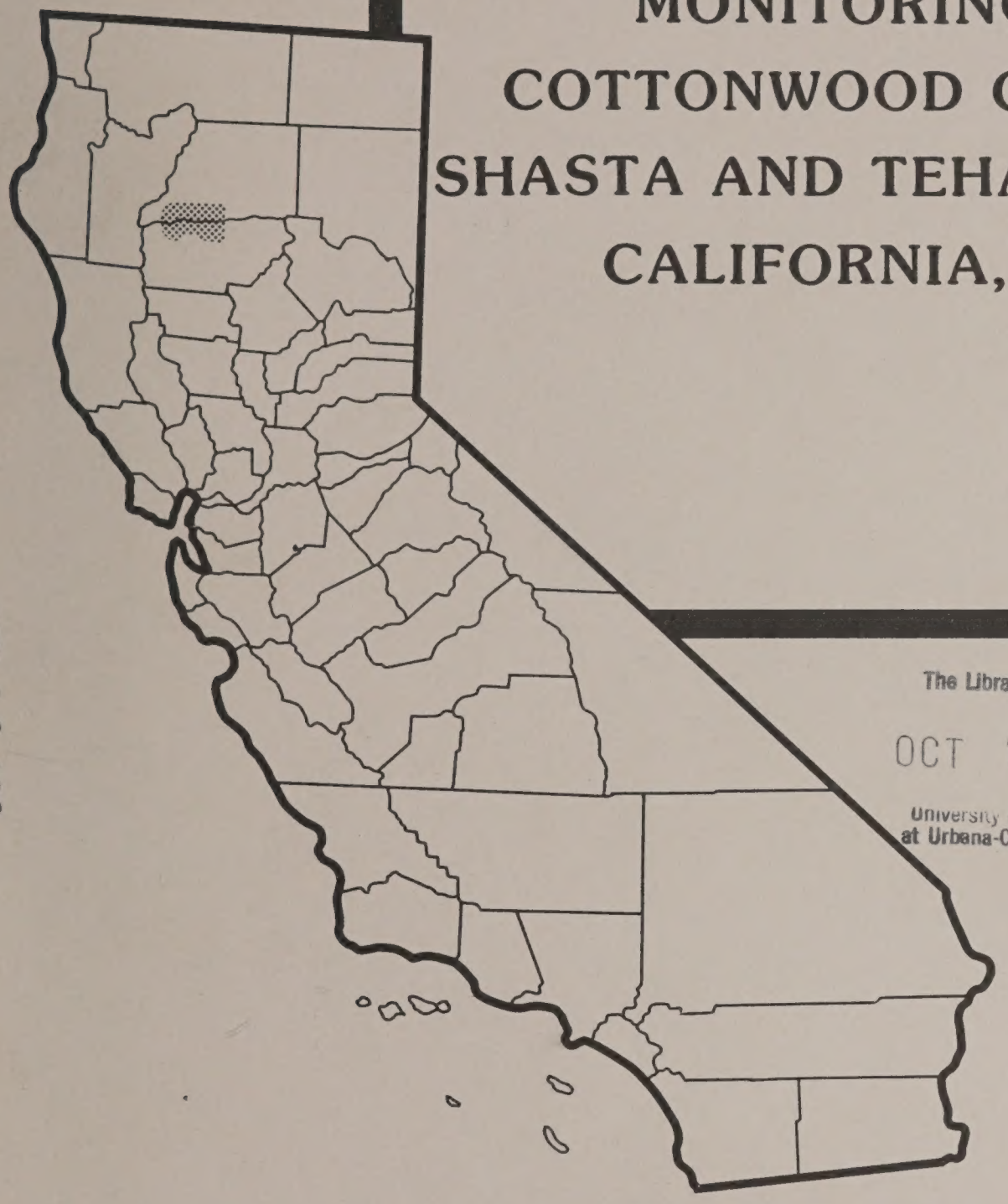
WATER-RESOURCES MONITORING IN THE COTTONWOOD CREEK AREA, SHASTA AND TEHAMA COUNTIES, CALIFORNIA, 1982-83



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U.S. GEOLOGICAL SURVEY
Water-Resources Investigations
Report 84-4187

Prepared in cooperation with the
U.S. ARMY CORPS OF ENGINEERS

WATER-RESOURCES MONITORING IN THE COTTONWOOD CREEK AREA, SHASTA AND TEHAMA COUNTIES, CALIFORNIA, 1982-83

By Ronald P. Fogelman and Kristin D. Evenson

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CONVERSION FACTORS

For readers who may prefer to use SI units rather than inch-pound units, the conversion factors for the terms used in this report are listed below:

Inch-pound	Multiply by	Metric (SI)
acre	4,047	square meter
ft (foot)	0.3048	meter
ft^3/s (cubic foot per second)	0.0283	cubic meter per second
in (inch)	25.4	millimeter
mi (mile)	1.609	kilometer

Temperature in degrees Fahrenheit (°F) can be converted to degrees Celsius (°C) as follows:

$$\text{Temp °C} = (\text{temp °F} - 32)/1.8$$

WATER-RESOURCES MONITORING IN THE COTTONWOOD CREEK AREA,

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ABSTRACT

The Cottonwood Creek study area, located in the Redding basin in northern California between Redding and Red Bluff, contains a network of surface-water sites and wells for monitoring surface-water quality and ground-water levels and quality. This network was established to provide baseline information on the ground-water conditions prior to the completion of two proposed dams, one to be located on Cottonwood Creek and one to be located on South Fork Cottonwood Creek.

Analysis of monthly ground-water levels from September 1982 through October 1983 shows that water levels are lowest in the autumn and highest in the spring. The ground-water surface slopes to the east and has a mound near the town of Cottonwood at the Anderson-Cottonwood Irrigation District Canal. Further studies in this area would provide information needed for any subsequent modeling studies. Data are also insufficient in the area upstream from the damsites, specifically in the areas of future impoundment, so the monitoring network could be expanded to include wells in these areas.

Comparison of ground-water quality samples from the period of lowest water levels to those collected during the period of highest water levels showed little chemical variation. Ground water is good to excellent with respect to recommended drinking-water standards. Chemical water types varied little throughout the area; ground water north of Cottonwood Creek is either sodium magnesium or magnesium sodium bicarbonate; south of Cottonwood Creek the predominant water type is calcium magnesium or magnesium calcium bicarbonate. Surface-water samples from Cottonwood Creek and South Fork Cottonwood Creek have water which is chemically similar to ground water from south of Cottonwood Creek.

INTRODUCTION

The U.S. Army Corps of Engineers is planning to construct dams on Cottonwood Creek and South Fork Cottonwood Creek in Shasta and Tehama Counties in northern California. As part of the planning phases of this project, the Corps of Engineers asked the U.S. Geological Survey to monitor ground-water levels and water quality in the lower Cottonwood Creek basin in order to define baseline, preconstruction conditions. In the autumn of 1982, the Survey established a network of observation wells to monitor both water levels and water quality. A network of surface-water sites also was established to monitor water quality in the main streams and their tributaries. This report documents the data collected during 1982-83.

Location and General Features

The Cottonwood Creek basin is located in the Redding basin west of the Sacramento River between Redding and Red Bluff (fig. 1). Cottonwood Creek is currently an unregulated stream that drains the eastern slopes of the Coast Ranges and flows eastward to its confluence with the Sacramento River. Two damsites, Dutch Gulch on Cottonwood Creek and Tehama on South Fork Cottonwood Creek, are located about 15 miles upstream from the Sacramento River. The area monitored for water levels and water quality is generally downstream from the damsites and upstream from the Sacramento River. There are few wells located on the borders of the area, especially in the areas adjacent to and within the areas of future impoundment.

Most of the ground-water development in the area has been for domestic purposes. The Anderson-Cottonwood Irrigation District Canal and Cottonwood Creek supply most of the water for agricultural needs.

The geology of the area has been described by many authors. The Corps of Engineers has performed detailed geologic investigations as part of their damsite evaluations, so a detailed discussion of the geology will not be included in this report. Briefly, the area is underlain by the Pliocene Tehama Formation which is characterized by fluviatile sediments of clay, silt, sand, and gravel derived from the Coast Ranges and has variable permeability (Olmsted and Davis, 1961, p. 36). The Pleistocene Red Bluff Formation unconformably overlies the Tehama Formation and is generally less than 50 ft thick. It is characterized by poorly sorted gravels having a reddish silty or sandy matrix (Olmsted and Davis, 1961, p. 35). The Red Bluff Formation is largely above the zone of saturation but may contain small bodies of perched water caused by intermittent layers of hardpan (Olmsted and Davis, 1961, p. 92-93).

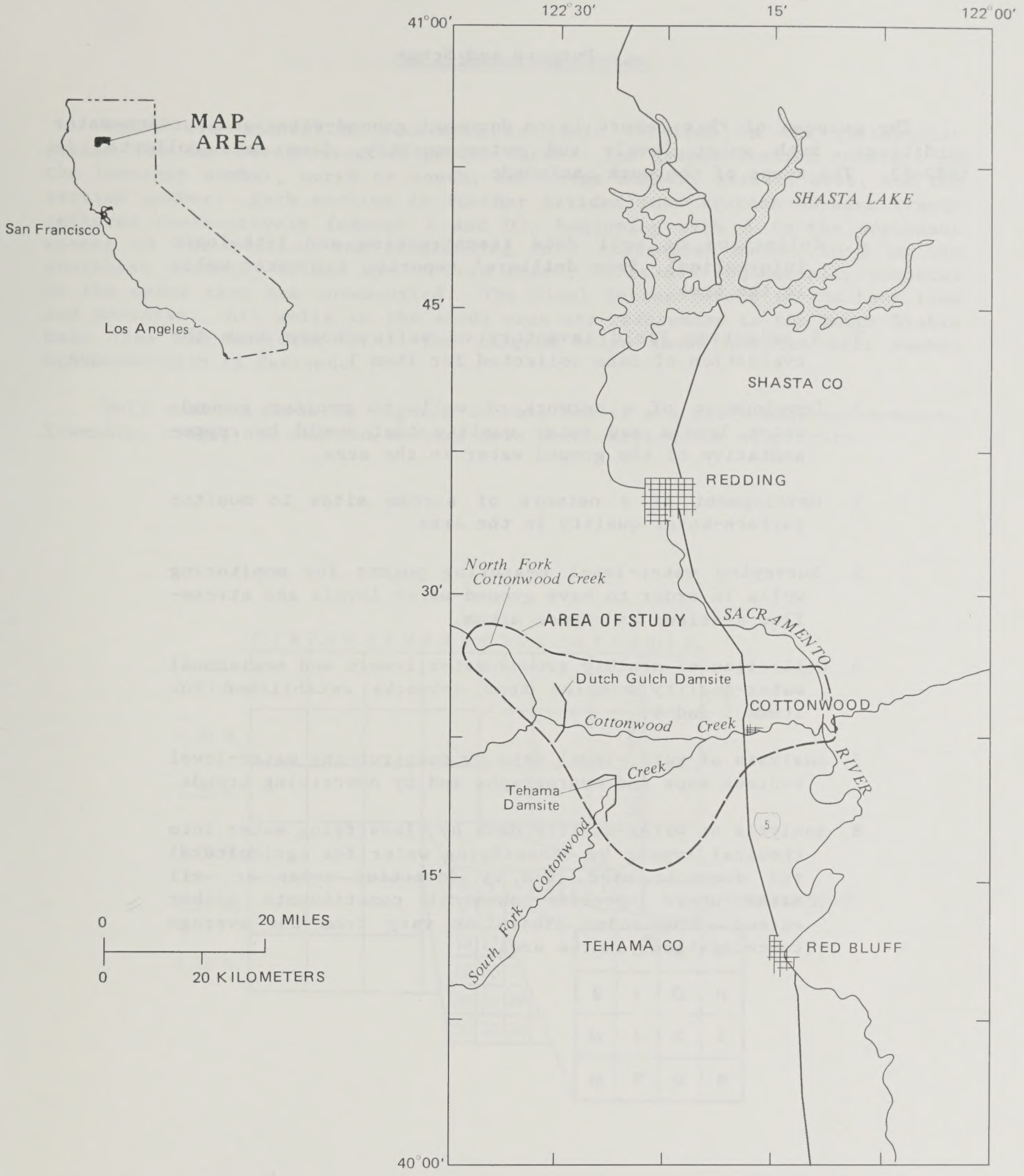


FIGURE 1.-Index map.

Purpose and Scope

The purpose of this report is to document ground-water and surface-water conditions, both water levels and water quality, from data collected in 1982-83. The scope of the work included:

1. Collection of well data (construction and lithologic information), from drillers' reports, for water wells in the area.

2. A selective field inventory of wells chosen from the evaluation of data collected for item 1.

3. Development of a network of wells to monitor ground-water levels and water quality that would be representative of the ground water in the area.

4. Development of a network of stream sites to monitor surface-water quality in the area.

5. Surveying water-level measuring points for monitoring wells in order to have ground-water levels and stream-flow stations at common datum.

6. Collection of monthly ground-water levels and semiannual water-quality samples from networks established for items 3 and 4.

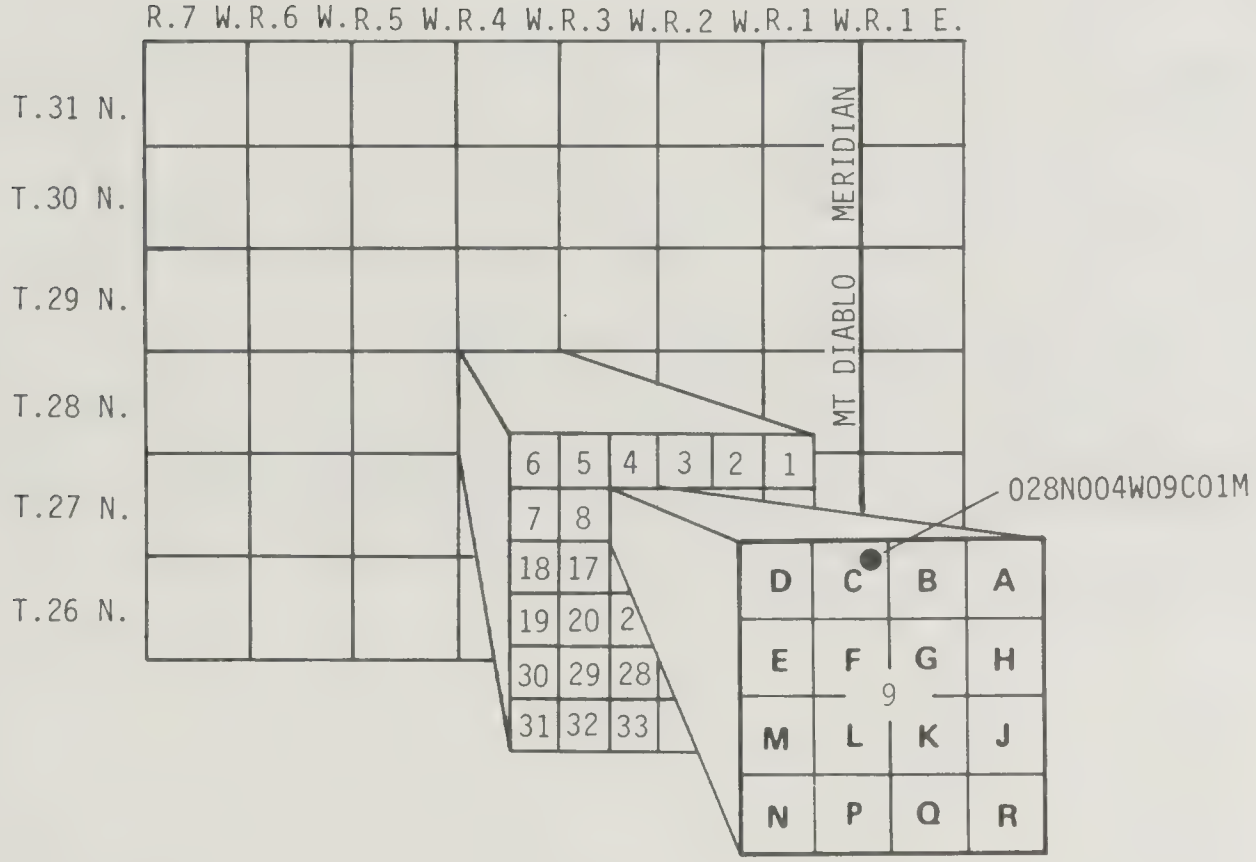
7. Analysis of water-level data by constructing water-level contour maps and hydrographs and by describing trends.

8. Analysis of water-quality data by classifying water into chemical types, by classifying water for agricultural and domestic uses, and by detecting areas or well sites where specific chemical constituents either exceed recommended limits or vary from the average concentrations in the area.

Well-Numbering System

Wells are identified according to their location in the rectangular system for the subdivision of public lands. The identification consists of the township number, north or south; the range number, east or west; and the section number. Each section is further divided into sixteen 40-acre tracts lettered consecutively (except I and O), beginning with A in the northeast corner of the section and progressing in a sinusoidal manner to R in the southeast corner. Within the 40-acre tract, wells are sequentially numbered in the order they are inventoried. The final letter refers to the base line and meridian. All wells in the study area are referenced to the Mount Diablo base line and meridian (M). The diagram below shows how the well number 028N004W09C01M is derived.

Well numbers shown in figures in this report are tract sequence numbers. Township, range, and section numbers have been omitted for simplicity.



ESTABLISHMENT OF MONITORING NETWORKS

During June and July 1982 about 200 wells were selectively inventoried. These wells were located from drillers' reports which contained thorough well-location and well-construction information. Only wells with complete well-construction information were included in either the water-level or water-quality network, as it was necessary to know what aquifer the measured or sampled water came from. Once a well was located, the fieldperson determined whether the well could be measured or sampled, updated construction data, obtained the owner's permission to measure or sample, and noted the exact measuring or sampling point.

From the 200 wells inventoried, about 100 wells were selected for the ground-water level monitoring network, and about 50 wells were selected for the ground-water quality monitoring network (pl. 1). These wells were considered adequate to represent the ground-water conditions in the area. Because of the development of ground water, most of the wells are located in the area downstream from the proposed damsites and generally near the two forks of Cottonwood Creek. The majority of these wells are domestic wells between 100 and 200 ft deep that penetrate layers of clays and gravels. Wells monitored near the borders of the area were also domestic wells penetrating clays and gravels; however, the depths varied in these wells. The shallowest and deepest wells in the monitoring network are located in the hills bordering the area.

Currently there are 97 wells in the water-level network; 94 are measured monthly, and 3 are equipped with continuous recorders. Currently there are 47 wells in the water-quality network. Several miscellaneous samples were taken from newly drilled Corps of Engineers' test wells. A summary of the data collected is given in tables 3, 4, and 5 at the end of this report.

About 25 surface-water sites selected for water-quality monitoring correspond with the current network of streamflow-measurement sites used for related studies. These sites are located at existing gaging stations and at miscellanous sites on the two forks of Cottonwood Creek and their tributaries (pl. 1). Water samples are collected semiannually from all sites that are flowing at the time of sampling. A summary of the data collected is given in table 6 at the end of the report.

CHEMICAL QUALITY OF WATER

Methods

Samples of ground water were taken from 47 wells during October 1982, May 1983, and October 1983. Samples from domestic wells or other wells having pressure systems were collected only after sufficient water had been pumped to assure obtaining a sample representative of water from the aquifer.

Surface-water quality samples were collected during May 1982, October 1982, and April 1983 at all sites where there was flow. Several sites were dry in the autumn and were sampled only in the spring.

Water temperature, specific conductance, pH, and alkalinity were measured at each sampling site. Temperature of the sample was simultaneously taken with a handheld thermometer and a direct-reading conductivity-temperature meter. A portable pH meter was used to determine pH, and the alkalinity was determined by the electrometric-titration process described by Brown and others (1970, p. 42). In an attempt to reduce human and instrument error, all determinations at the well site were made at least twice. When field determinations were completed, the remaining sample was field treated and refrigerated until being shipped to the U.S. Geological Survey Denver Central Laboratory in Arvada, Colo., for laboratory analysis. Samples that required it were filtered with a 0.45-micrometer membrane filter. Samples to be analyzed for nutrients were chilled by packing in ice immediately after filtering.

At the Denver Central Laboratory, all samples were analyzed for concentrations of calcium, magnesium, sodium, potassium, alkalinity, chloride, sulfate, nitrate plus nitrite as nitrogen, fluoride, silica, dissolved solids (residue on evaporation at 180°C method), aluminum, arsenic, iron, manganese, and orthophosphate using methods described by Brown and others (1970). The October 1982 samples also were analyzed for boron. Samples from three depth intervals from well 029N006W02P01M also were analyzed for trace metals (table 5). Physical well data are on file in the Survey computer and office files. The results of field and laboratory analyses are shown in table 4.

Water-Quality Standards

In this report the chemical constituents and properties are discussed in terms of their importance from the standpoint of toxicity or annoyance to humans and from the standpoint of toxicity to agricultural crops (phytotoxicity). Concentrations are compared with Federal standards. As a result of the Safe Drinking Water Act (Public Law 93-523), the U.S. Environmental Protection Agency (EPA) issued the National Interim Primary Drinking Water Regulations (1977) and the National Secondary Drinking Water Regulations (1979) (table 1). The term "Primary" in the title refers to mandatory limits as they pertain to public health. The term "Secondary" refers to recommended limits as they pertain to aspects of public water supplies that affect the public welfare in ways not related to health, such as an aesthetic characteristic of the water. These limits are used in this report for comparison and represent statutory limitations on public drinking-water supplies and not on private residential water sources. The local authority is the State of California, which adopted and described the Federal standards in the California Domestic Water Quality and Monitoring Regulations (California Department of Health, Sanitary Engineering Section, 1977).

Recommended limits for constituents in water used for agriculture (table 1) are given in National Academy of Sciences and National Academy of Engineering (1973).

Table 1.-- Drinking and agricultural water standards

Constituent	U.S. Environmental Protection Agency drinking-water standards		Recommended maximum concentrations in irrigation water[3]
	Primary[1]	Secondary[2]	
	Maximum concentration, in milligrams per liter		
Aluminum	--	--	5.0-20.0
Arsenic	0.05	--	0.1-2.0
Boron	--	--	[4]0.75-1.0-2.0
Chloride	--	250	--
Dissolved solids	--	500	--
Fluoride	[5]1.6	--	1.0-15.0
Iron	--	0.3	5.0-20.0
Manganese	--	0.05	0.2-10.0
Nitrate (as nitrogen)	10	--	--
Sulfate	--	250	--

[1]U.S. Environmental Protection Agency, 1977.

[2]U.S. Environmental Protection Agency, 1979.

[3]National Academy of Sciences and National Academy of Engineering, 1973. If two values are given, the lower value is the maximum recommended for use continuously on all soils. The upper value is the maximum recommended for use up to 20 years on fine-textured, neutral to alkaline soils.

[4]The three values shown denote the maximum concentration recommended for continuous use on all soils for boron sensitive crops, semitolerant crops, and tolerant crops, respectively.

[5]Based on mean annual maximum daily air temperature between 22 and 26°C.

Water Types

Water can be classified into general chemical types by use of a system based on the relative concentration of major cations and anions, as in the following examples: A "calcium bicarbonate" type water designates water in which calcium amounts to 50 percent or more of the cations and bicarbonate to 50 percent or more of the anions, in chemical equivalents; "sodium calcium bicarbonate" designates water in which the sodium and calcium are first and second, respectively, in order of abundance among the cations but neither amounts to 50 percent of all the cations; "sodium sulfate bicarbonate" designates water in which the sulfate and bicarbonate are first and second in order of abundance among the anions, as above (Piper, Garrett, and others, 1953).

The distribution of water types in ground water throughout the Cottonwood Creek area, based on the samples collected during October 1982, is shown on plate 2. South of Cottonwood Creek (generally south of Gas Point Road), ground water is a calcium magnesium or magnesium calcium bicarbonate type. Within this general water-type combination, the area along the South Fork of Cottonwood Creek and along Pine Creek shows water of a more calcium-rich nature. North of Cottonwood Creek the ground-water type is a sodium magnesium or magnesium sodium bicarbonate. The trilinear diagram (fig. 2) shows this variation in water types.

Samples collected during May 1983 display similar water-type patterns. However, water from 13 wells differed in water type from October 1982 samples due to small changes in ionic concentrations.

Water samples also were collected from the main streams and tributaries in the same months as the ground-water samples. The water type determined for the surface water was a calcium magnesium or magnesium calcium bicarbonate, which is similar to the chemical character of ground water sampled in the area. The calcium-rich waters in the South Fork Cottonwood Creek-Pine Creek areas indicated for ground water also were observed in the surface water (fig. 2).

Strand (1962) showed the area south of Cottonwood Creek to be underlain by the continental Tehama Formation which may explain the calcium-rich nature of the ground water. The area north of Cottonwood Creek is underlain by the Red Bluff Formation. The thin (usually less than 50 ft thick) Red Bluff Formation overlies the interbedded Tehama and Tuscan Formations (Olmsted and Davis, 1961, p. 90); however, the sodium-rich water type may suggest that the source area of the ground water may be in the older marine Cretaceous sedimentary rocks of the Coast Ranges, possibly the Chico Formation or lower Cretaceous rocks (formerly called Shasta Series, now obsolete).

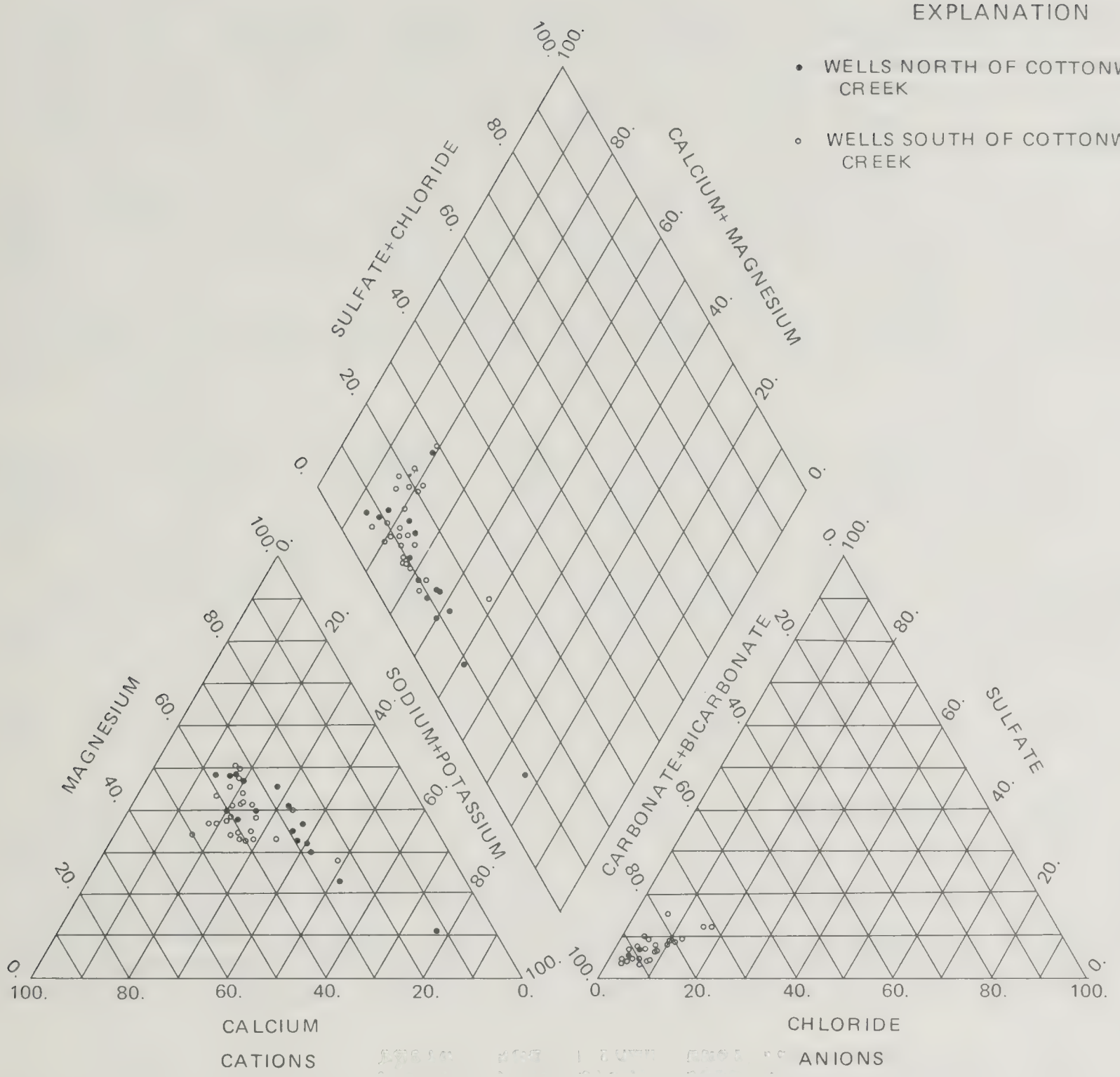


FIGURE 2.-Trilinear diagram showing water quality in the Cottonwood Creek area, October 1982.

Summary of Chemical Analyses

Ground Water

Ground-water quality in the Cottonwood Creek area is considered good to excellent with respect to recommended drinking-water standards. The ranges of concentrations and the mean and median concentrations found in the Cottonwood Creek area for samples collected during October 1982 and May 1983 are shown in table 2. The results of the individual field and lab analyses are shown in tables 4 and 5 at the end of this report.

Water from well 029N006W02K01M (actually located in 029N005W06P) had high nitrate (as nitrogen) concentrations (12 mg/L during October 1982 and 9.2 mg/L during May 1983). The EPA primary drinking-water limit for nitrate (as nitrogen) is 10 mg/L. Generally the most abundant form of nitrogen in ground water is nitrate (Hem, 1970); therefore, total nitrogen values were assumed to be roughly equivalent to nitrate concentrations. In this study all water samples were analyzed for dissolved nitrite plus nitrate as nitrogen.

Nitrate toxicity does not usually affect adults and older children, but it may cause a temporary blood disorder known as methemoglobinemia in children less than 4 months old; it occasionally is fatal. The incidence of fatality is very low in the United States where public water supplies are used. Most cases of nitrate toxicity are associated with high nitrate concentrations in domestic wells caused by inadequate sealing of supplying aquifers from surface contaminations.

For most agricultural purposes, nitrate in irrigation water is considered an asset because of its nutrient value; therefore, no limits have been established for nitrate-nitrogen in irrigation water.

Well 029N006W02K01M is a shallow domestic well located at a farmhouse surrounded by pasture. The depth of the well is 100 ft, the first perforation open to the formation is at 60 ft, and water levels have fluctuated from about 30 to 50 ft below land surface. The shallow well depth, shallow water level, and locale of this well lead to the conclusion that the nitrate problem is probably a result of surface contamination. It is only a local point-source problem and is not indicative of nitrate concentrations in the ground water of the area.

Water from test well 029N006W06P01M drilled by the Corps of Engineers exceeded the EPA primary drinking-water limit for arsenic at two of the three depth intervals sampled. Water samples from 246 ft had an arsenic concentration of 0.066 mg/L, and samples from 176 ft had an arsenic concentration of 0.06 mg/L.

Arsenic can be acutely or chronically toxic to humans and plants. The EPA has established 0.05 mg/L as the primary drinking-water standard. The National Academy of Sciences and National Academy of Engineering (1973) recommended maximum concentrations of 0.1 mg/L for irrigation water and 0.2 mg/L for livestock watering.

Water from wells 030N006W10K02M and 029N006W12B01M exceeded the 0.05-mg/L secondary standard for manganese, with concentrations of 0.066 and 0.13 mg/L, respectively. Manganese is objectionable in public water supplies because it affects taste, stains plumbing fixtures, spots laundered clothes, and causes accumulation of oxide deposits in distribution systems.

Manganese concentrations of a few tenths to a few milligrams per liter in solution are toxic to some plants. For this reason, a limit of 0.2 mg/L has been recommended for manganese in irrigation water used continuously on all soils. It should be noted that higher concentrations of manganese in irrigation water can be tolerated, depending on individual plant sensitivity and soil texture, drainage, pH, and alkalinity and in duration or continuity of application (National Academy of Sciences and National Academy of Engineering, 1973).

Well 029N006W02P01M was sampled at three intervals during October 25-26, 1982, for trace metals as well as the standard chemical analyses used in the semiannual ground-water samples. The sample depths were 246 ft, 176 ft, and 104 ft.

These samples show that concentrations of calcium, magnesium, sulfate, manganese, cadmium, molybdenum, strontium, and vanadium decrease with increasing depth, and dissolved solids, sodium, alkalinity, chloride, arsenic, boron, lead, lithium, and zinc concentrations increase with increasing depth.

Surface Water

Surface-water quality samples from Cottonwood Creek, South Fork Cottonwood Creek, and their tributaries were collected during the spring and autumn to reflect the high- and low-flow periods. Water-quality analyses from the samples of May and October 1982 and April 1983 are listed in table 6 at the end of the report.

Comparison of the spring and autumn analyses shows that there was generally an increase in concentrations of major ions during the low-flow periods. Dissolved-solids concentrations ranged from 48 to 163 mg/L and from 43 to 248 mg/L and had mean concentrations of 121 and 102 mg/L in the spring analyses of 1982 and 1983, respectively, whereas dissolved-solids concentrations ranged from 63 to 214 mg/L and had a mean concentration of 139 mg/L in the autumn.

Table 2.--Summary of ground-water-quality data

[Specific conductance is in microsiemens per centimeter at 25° Celsius. pH is in units. Temperature is in degrees Celsius. All other values are in milligrams per liter. All constituents are dissolved unless otherwise noted. <, actual value is less than value shown. --, no data available]

Properties and constituents	October 1982	May 1983	October 1983
Specific conductance:			
Minimum-maximum	75-424	58-412	64-516
Mean	243	248	240
Median	234	226	226
pH:			
Minimum-maximum	6.4-8.1	6.5-8	6.4-8.2
Mean	7.4	7.2	7.3
Median	7.3	7.1	7.3
Temperature:			
Minimum-maximum	11-20	15.5-22.5	14-21.5
Mean	17.2	19	18
Median	17.5	18.5	18
Hardness as $CaCO_3$:			
Minimum-maximum	18-189	16-180	16-200
Mean	97	99	97
Median	92	90	92.5
Hardness, noncarbonate:			
Minimum-maximum	0-67	0-50	0-69
Mean	3	4	3.5
Median	0	0	0
Calcium (Ca):			
Minimum-maximum	3.3-42	3.1-39	3.2-38
Mean	19	19	19
Median	17	18	17
Magnesium (Mg):			
Minimum-maximum	2.3-27	2-25	1.9-28
Mean	12	13	12
Median	12	11	10
Sodium (Na):			
Minimum-maximum	6.3-25	6.4-20	6.5-40
Mean	14	13	14
Median	13	13	13
Potassium (K):			
Minimum-maximum	0.3-3	0.3-3	0.3-3
Mean	0.8	0.8	0.87
Median	0.7	0.7	0.7
Alkalinity, total as $CaCO_3$:			
Minimum-maximum	28-185	25-170	25-180
Mean	109	108	107
Median	113	110	110
Sulfate (SO_4):			
Minimum-maximum	<5-24	0.2-20	0.5-26
Mean	--	6.1	6.6
Median	--	5	4.8

Table 2.--Summary of ground-water-quality-data--Continued

Properties and constituents	October 1982	May 1983	October 1983
Chloride (Cl):			
Minimum-maximum	1.7-23	1.3-20	1.6-45
Mean	6.2	6.7	7.8
Median	3.7	3.9	4
Fluoride (F):			
Minimum-maximum	0.1-0.2	<0.1-0.2	<0.1-0.2
Mean	--	--	--
Median	--	--	--
Silica (SiO_2):			
Minimum-maximum	17-74	20-74	9.5-70
Mean	42	43	41.4
Median	43	42	42
Dissolved solids, residue at 180°C:			
Minimum-maximum	76-304	70-277	71-306
Mean	166	162	164.2
Median	156	155	151.5
Nitrogen, NO_2 + NO_3:			
Minimum-maximum	0.1-12	0.2-9.2	0.17-14
Mean	1.5	1.8	1.5
Median	0.9	0.9	0.9
Phosphorus, ortho as P:			
Minimum-maximum	<0.01-0.22	<0.02-0.25	<0.01-0.23
Mean	--	--	--
Median	--	--	--
Aluminum (Al):			
Minimum-maximum	<0.01-0.02	<0.01-0.02	--
Mean	--	--	--
Median	--	--	--
Arsenic (As):			
Minimum-maximum	<0.001-<0.003	<0.001-<0.003	--
Mean	--	--	--
Median	--	--	--
Boron (B):			
Minimum-maximum	<0.01-0.05	--	<0.01-0.09
Mean	--	--	--
Median	--	--	--
Iron (Fe):			
Minimum-maximum	<0.003-0.17	<0.003-0.05	<0.003-0.26
Mean	--	--	--
Median	--	--	--
Manganese (Mn):			
Minimum-maximum	<0.001-0.066	<0.001-0.02	<0.001-0.093
Mean	--	--	--
Median	--	--	--

GROUND-WATER LEVELS

Description of Ground-Water Levels

Water-level maps of September 1982 (pl. 3) and March 1983 (pl. 4) show altitudes of the ground-water surface based on water-level measurements. These maps show the low and the high ground-water conditions in the study area. The maps for both September and March show the same eastward, downstream slope of the ground-water surface from the damsites. Also apparent in both maps is a ground-water mound located between the confluence of the South Fork of Cottonwood Creek and the town of Cottonwood; in both months this mound was approximately the same size and shape. Water levels from wells in this area changed less throughout the year as compared with wells in the rest of the study area. The Anderson-Cottonwood Irrigation District Canal runs through the center of this area; because it is not lined it is probably the cause of the higher ground-water levels and suppressed water-level fluctuations. Water levels downstream from the town of Cottonwood also slope generally eastward toward the Sacramento River.

After an analysis was made of the relation of water levels to well depth (or depth to the first perforation), it was determined that generally the deeper the well the deeper the water level. The basin area near the creeks, where well depths showed little variation, indicates that water-table conditions exist, as shown by the rapid response to precipitation shown in figures 3-5 and the contour maps (pls. 3 and 4). The water levels in many of the wells in the bordering areas varied with respect to the contours drawn between the wells in the basin area, indicating that local conditions such as local confinement or perched water may exist. Contours were not extended to these bordering wells.

Results of pumping tests with multilevel piezometers performed by the Corps of Engineers at the proposed Tehama and Dutch Gulch damsites indicate that confined flow conditions exist at those sites (Carl Cole, U.S. Army Corps of Engineers, oral commun., 1983).

Hydrographs

Water-level fluctuations in the Cottonwood Creek area are representative of the basin part of the study area as can be seen by the location of each of the groups of wells. Wells located close to the proposed Dutch Gulch damsite are shown in figure 3, and wells located along South Fork Cottonwood Creek near the proposed Tehama damsite are shown in figure 4.

The changes in water levels shown in the hydrographs for wells in the ground-water mound area (fig. 5) are different from those of the rest of the study area. Although water levels in these wells fluctuate throughout the year, the range of fluctuation is much less than the range of fluctuations found over the rest of the area. Leakage from the Anderson-Cottonwood Irrigation District Canal may cause this mound and could explain the suppressed fluctuations of water levels in these wells.

The three hydrographs show virtually the same seasonal patterns. The lowest water levels occurred from September to November and then rose through March; from April through July water levels declined. Precipitation records from the station located at the Coleman Fish Hatchery show the same pattern as the water levels, indicating that water levels respond quickly to precipitation.

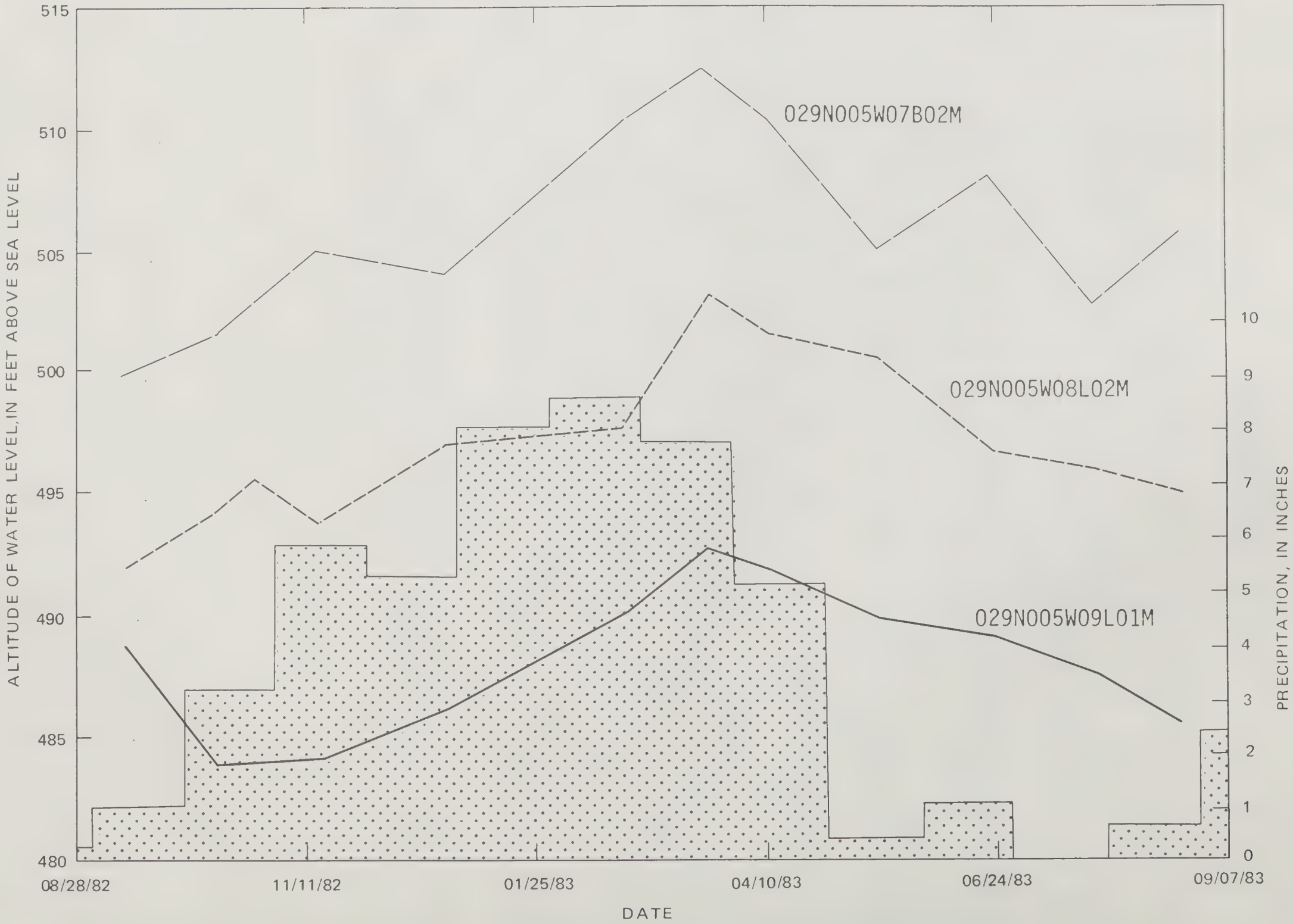


FIGURE 3.-Hydrographs of wells near Dutch Gulch damsite and precipitation at Coleman Fish Hatchery.

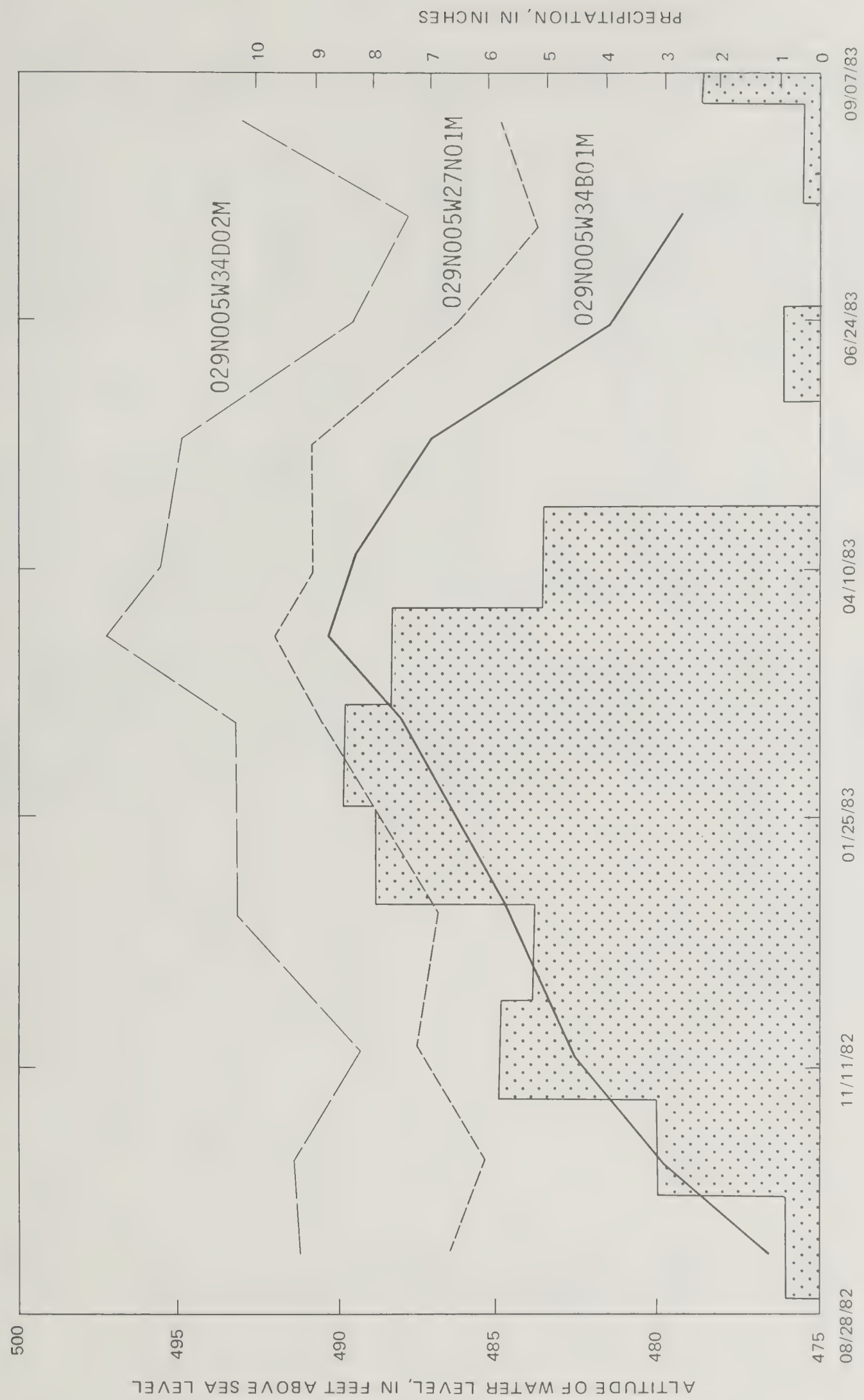


FIGURE 4.-Hydrographs of wells near Tehama damsite and precipitation at Coleman Fish Hatchery.

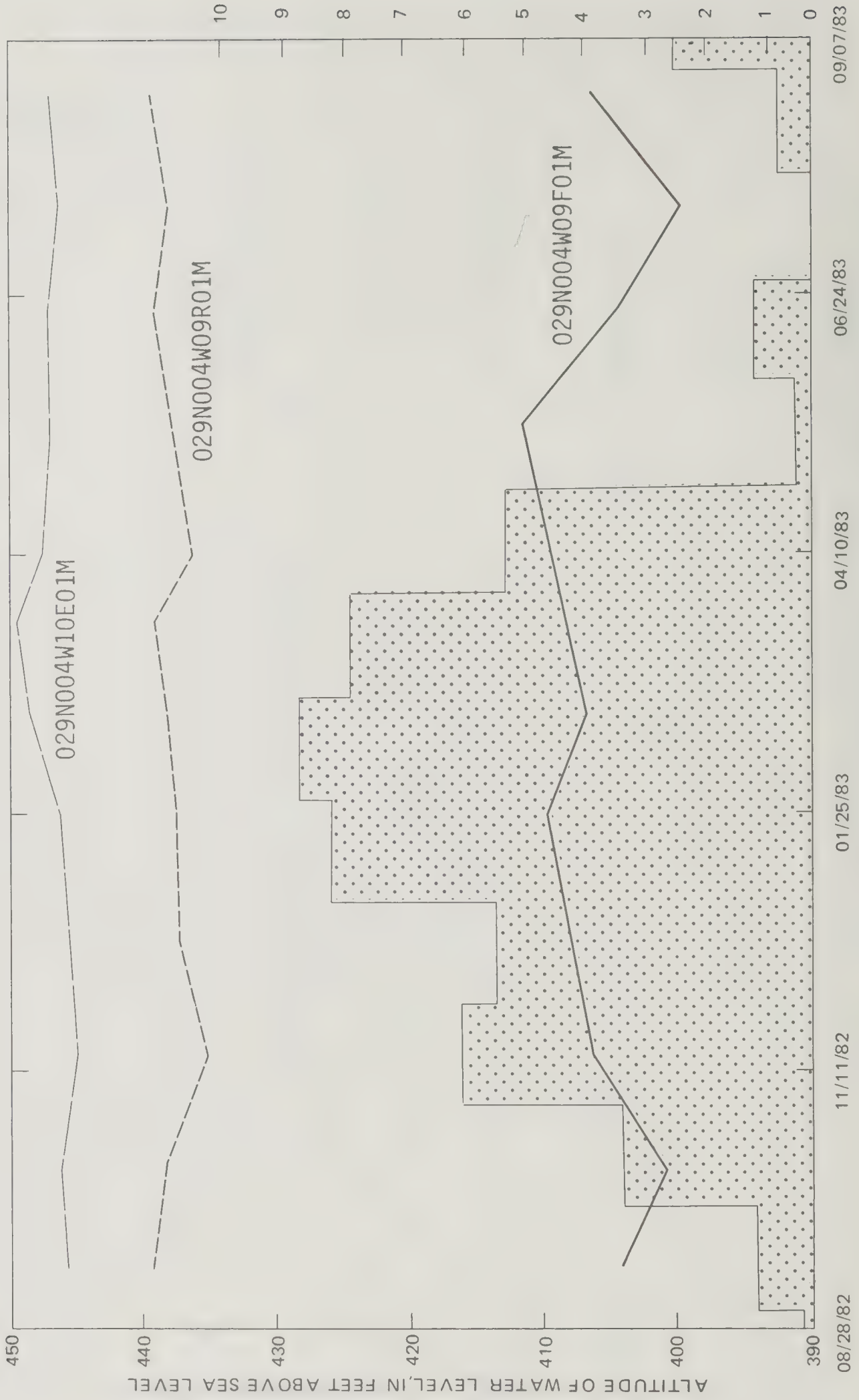


FIGURE 5.-Hydrographs of wells near Cottonwood and precipitation at Coleman Fish Hatchery.

SUMMARY AND CONCLUSIONS

Ground-water quality in the Cottonwood Creek area is considered good to excellent with respect to recommended standards. Chemical quality varied little both spatially and seasonally.

Ground-water levels were higher in the spring and lower in the autumn, coinciding with precipitation patterns. The ground-water surface slopes downstream from the damsites toward the Sacramento River, but two areas are anomalous to this trend. One area is a ground-water mound near the town of Cottonwood where the probable cause is leakage from the Anderson-Cottonwood Irrigation District Canal. The other area is in the hills that border the basin on the north and south. Inspection of drillers' logs from wells in this area indicates that clay layers are present and could cause local confinement or perched water in some wells.

Data are insufficient in the area upstream from the damsites, specifically in the areas of future impoundment. These areas are likely to experience the greatest impacts from the dams, so the monitoring network could be expanded to include wells in these areas. At this time (1984), information has not been located for wells in this area. A detailed well inventory and local research may successfully locate suitable monitoring wells. It may be necessary to drill new wells in areas where no wells exist.

Further studies in the area of the ground-water mound near the town of Cottonwood might provide the reasons for the existence of the mound. The data included in this report indicate that water levels do not fluctuate in the mound area as they do in the rest of the study area. Detailed information of the hydrology in this area would be needed for any subsequent modeling studies.

SELECTED REFERENCES

Brown, Eugene, Skougstad, M. W., and Fishman, M. J., 1970, Methods for collection and analysis of water samples for dissolved minerals and gases: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 5, Chapter A1, 160 p. [Superseded by Skougstad, M. W., Fishman, M. J., Friedman, L. C., Erdmann, D. E., and Duncan, S. S., eds., 1979, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 5, Chapter A1, 626 p.]

California Department of Health, Sanitary Engineering Section, 1977, California domestic water quality and monitoring regulations: California Health and Safety Code and California Administrative Code, Title 22, 22 p.

Hem, J. D., 1970, Study and interpretation of the chemical characteristics of natural water (2d ed.): U.S. Geological Survey Water-Supply Paper 1473, 363 p.

National Academy of Sciences and National Academy of Engineering, 1973 (1974), Water quality criteria, 1972: U.S. Environmental Protection Agency, EPA R3-73-033, 594 p.

National Oceanic and Atmospheric Administration, 1982, Climatological data, annual summary, California, 1982: v. 86, no. 13.

_____1983, Climatological data, California, January-June, 1983: v. 87, no. 1-6.

Olmsted, F. H., and Davis, G. H., 1961, Geologic features and ground-water storage capacity of the Sacramento Valley, California: U.S. Geological Survey Water-Supply Paper 1497, 241 p.

Pierce, M. J., 1983, Ground water in the Redding Basin, Shasta and Tehama Counties, California: U.S. Geological Survey Water-Resources Investigations Report 83-4052, 37 p.

Piper, A. M., Garrett, A. A., and others, 1953, Native and contaminated ground waters in the Long Beach-Santa Ana area, California: U.S. Geological Survey Water-Supply Paper 1136, 320 p.

Strand, R. G., 1962, Geologic map of California--Redding sheet: California Division of Mines and Geology, scale 1:250,000.

U.S. Environmental Protection Agency, 1977, National interim primary drinking water regulations: U.S. Environmental Protection Agency, Office of Water Supply, EPA 570/9-76-003, 159 p.

_____1979, National secondary drinking water regulations: Federal Register, v. 44, no. 140, July 19, 1979, p. 42195-42202.

TABLES 3-6

Table 3.--Water levels in wells

[Water levels reported in feet below land-surface datum.
P indicates pumping water-level measurement]

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Well 028N004W08K01M Site No. 401734122202201							
Highest water level 127.74 ft, June 24, 1983; lowest 138.58 ft, May 20, 1983.							
09/16/82	128.34	12/29/82	138.13	04/13/83	132.98	07/26/83	131.13
10/25	129.96	02/26/83	128.19	05/20	138.58	08/25	134.33
11/18	133.48	03/23	128.09	06/24	127.74		
Well 028N004W09C01M Site No. 401805122191901							
Highest water level 169.35 ft, June 24, 1983; lowest 182.19 ft, Nov. 18, 1982.							
09/16/82	170.62	12/29/82	176.50	04/13/83	178.36	08/25/83	173.76
10/25	177.44	02/28/83	177.83	06/24	169.35	09/22	169.57
11/18	182.19	03/23	176.08	07/27	169.51		
Well 028N005W01P01M Site No. 401817122224201							
Highest water level 133.14 ft, Mar. 23, 1983; lowest 166.28 ft, July 27, 1983.							
09/16/82	143.14	12/29/82	144.68	04/13/83	P151.83	07/27/83	166.28
10/27	141.87	02/28/83	141.64	05/17	P167.42	08/25	154.71
11/18	140.22	03/23	133.14	06/24	151.83		
Well 028N005W05G01M Site No. 401846122270501							
Highest water level 81.16 ft, May 17, 1983; lowest 90.98 ft, Nov. 17, 1982.							
09/16/82	88.39	12/28/82	86.86	04/13/83	81.39	07/27/83	86.27
10/26	86.07	02/25/83	85.34	05/17	81.16	08/25	89.30
11/17	90.98	03/23	81.32	06/24	84.79	09/26	P93.35
Well 028N005W09F01M Site No. 401754122261401							
Highest water level 194.36 ft, Sept. 22, 1983; lowest 209.77 ft, Dec. 29, 1982.							
09/16/82	196.22	12/29/82	209.77	04/13/83	201.58	07/27/83	196.34
10/27	204.12	02/28/83	203.06	05/17	202.74	08/25	197.96
11/18	206.47	03/23	195.50	06/24	201.25	09/22	194.36
Well 028N005W10B01M Site No. 401803122244601							
Highest water level 272.03 ft, Sept. 16, 1982; lowest 287.90 ft, Dec. 29, 1982.							
09/16/82	272.03	12/29/82	287.90	04/13/83	277.28	07/26/83	276.36
10/25	286.24	02/28/83	276.80	05/18	273.73	08/25	280.65
11/18	272.07	03/23	274.79	06/24	273.29	09/22	279.83

Table 3.--Water levels in wells--Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level

Well 028N005W11D01M Site No. 401803122240401

Highest water level 242.18 ft, Feb. 28, 1983; lowest 251.71 ft, Aug. 25, 1983.

09/16/82	P248.66	02/28/83	242.18	05/17/83	246.97	08/25/83	251.71
10/25	246.00	03/23	243.08	06/24	246.22	09/22	249.61
11/18	250.35	04/13	248.62	07/26	249.28		

Well 028N005W13A01M Site No. 401716122221201

Highest water level 204.33 ft, Mar. 23, 1983; lowest 233.60 ft, Dec. 29, 1982.

09/16/82	211.91	11/18/82	209.73	02/28/83	207.08	04/13/83	210.66
10/25	217.39	12/29	233.60	03/23	204.33	05/18	225.29

Well 028N005W14F01M Site No. 401659122235501

Highest water level 201.11 ft, Mar. 23, 1983; lowest 226.68 ft, May 18, 1983.

09/16/82	215.37	02/25/83	201/90	05/18/83	226.68	08/25/83	219.91
10/25	223.19	03/23	201.11	06/24	211.67	09/21	219.13
11/18	225.61	04/13	212.98	07/27	216.53		

Well 028N005W27D01M Site No. 401525122252301

Highest water level 262.72 ft, Nov. 18, 1982; lowest 280.15 ft, Sept. 16, 1982.

09/16/82	280.15	12/29/82	276.20	04/13/83	275.67	07/27/83	277.48
10/25	276.10	02/28/83	278.58	05/20	275.58	08/25	279.98
11/18	262.72	03/23	272.09	06/24	275.51	09/22	275.39

Well 029N003W04N01M Site No. 402335122125401

Highest water level 34.59 ft, Mar. 21, 1983; lowest 38.82 ft, Sept. 15, 1982.

09/15/82	38.82	01/25/83	38.63	04/11/83	35.07	07/21/83	37.45
10/13	38.39	02/23	36.15	05/16	35.78	08/23	37.87
11/15	38.77	03/21	34.59	06/21	36.56	09/20	38.13
12/20	37.39						

Well 029N003W06L01M Site No. 402348122144301

Highest water level 45.42 ft, May 17, 1983; lowest 50.85 ft, Nov. 15, 1982.

09/15/82	48.14	01/25/83	47.49	04/11/83	48.38	07/21/83	50.58
10/13	49.23	02/23	46.79	05/17	45.42	08/23	48.48
11/15	50.85	03/21	48.12	06/21	46.31	09/20	48.39
12/27	47.88						

Table 3.--Water levels in wells--Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Well 029N003W07D01M Site No. 402321122150301							
Highest water level 23.87 ft, Mar. 21, 1983; lowest 36.59 ft, June 21, 1983.							
09/15/82	28.20	01/25/83	25.08	04/11/83	27.14	07/21/83	28.5
10/13	27.93	02/23	26.63	05/17	25.37	08/23	27.98
11/15	28.07	03/21	23.87	06/21	26.59	09/24	27.62
12/20	27.94						
Well 029N004W01J01M Site No. 402347122151901							
Highest water level 34.27 ft, Apr. 11, 1983; lowest 41.95 ft, Oct. 13, 1982.							
09/15/82	38.12	01/25/83	37.88	04/11/83	34.27	07/21/83	38.08
10/13	41.95	02/23	37.24	05/16	34.8	08/23	37.57
11/15	40.14	03/21	37.35	06/21	36.12	09/20	39.21
12/20	36.25						
Well 029N004W02K01M Site No. 402335122164801							
Highest water level 52.03 ft, Mar. 21, 1983; lowest 62.92 ft, Nov. 15, 1982.							
09/15/82	57.70	01/25/83	58.90	04/11/83	52.57	07/21/83	55.
10/13	59.70	02/23	53.24	05/17	52.85	08/23	55.73
11/15	62.92	03/21	52.03	06/21	54.18	09/20	55.64
12/20	58.46						
Well 029N004W02P01M Site No. 402328122171101							
Highest water level 55.33 ft, Mar. 21, 1983; lowest 59.63 ft, Dec. 20, 1982.							
10/27/82	59.47	01/25/83	57.20	04/11/83	55.52	07/21/83	58.13
11/15	59.63	02/23	56.12	05/17	55.88	08/23	58.97
12/20	57.86	03/21	55.33	06/21	57.46	09/20	58.79
Well 029N004W03R01M Site No. 402324122174501							
Highest water level 14.11 ft, Aug. 23, 1983; lowest 18.52 ft, Nov. 16, 1982.							
09/15/82	14.53	01/25/83	16.32	04/11/83	17.55	07/21/83	15.43
10/13	15.23	02/23	15.44	05/10	15.9	08/23	14.11
11/16	18.52	03/21	14.46	06/21	14.29	09/20	14.37
12/20	16.26						
Well 029N004W04Q01M Site No. 402331122191201							
Highest water level 108.09 ft, May 17, 1983; lowest 122.52 ft, Nov. 15, 1982.							
09/14/82	113.39	01/25/83	121.43	04/11/83	111.53	07/21/83	115.96
10/13	119.63	02/23	121.97	05/17	108.09	08/23	115.94
11/15	122.52	03/21	121.42	06/21	109.73	09/20	121.53
12/27	118.54						

Table 3.--Water levels in wells--Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Well 029N004W06R01M Site No. 402336122210001							
Highest water level 143.46 ft, June 21, 1983; lowest 157.45 ft, Sept. 20, 1983.							
09/14/82	146.88	01/25/83	147.38	04/11/83	P153.78	07/21/83	144.40
10/13	146.77	02/23	147.45	05/19	144.1	08/23	149.31
11/16	153.02	03/21	147.34	06/21	143.46	09/20	157.45
12/27	145.09						
Well 029N004W07G02M Site No. 402303122212201							
Highest water level 47.46 ft, Apr. 11, 1983; lowest 56.96 ft, July 21, 1983.							
10/13/82	54.24	05/19/83	49.73	07/21/83	56.96	09/20/83	56.42
04/11/83	47.46	06/21	52.46	08/23	50.90		
Well 029N004W09F01M Site No. 402300122192001							
Highest water level 58.12 ft, May 18, 1983; lowest 69.80 ft, July 21, 1983.							
09/14/82	65.72	01/25/83	60.02	04/11/83	60.39	07/21/83	69.80
10/13	68.82	02/23	63.18	05/18	58.12	08/23	63.04
11/16	63.50	03/21	61.57	06/21	65.27	09/20	63.46
Well 029N004W10E01M Site No. 402308122183201							
Highest water level 11.83 ft, Mar. 21, 1983; lowest 16.74 ft, Nov. 15, 1982.							
09/15/82	15.92	01/25/83	15.48	04/11/83	13.84	07/21/83	15.46
10/13	15.24	02/23	13.2	05/17	14.59	08/23	14.59
11/15	16.74	03/21	11.83	06/21	14.30	09/20	15.29
12/20	16.2						
Well 029N004W10H01M Site No. 402305122173201							
Highest water level 55.53 ft, Apr. 11, 1983; lowest 83.39 ft, Oct. 13, 1982.							
09/15/82	60.44	01/25/83	56.89	04/11/83	55.53	07/21/83	P79.08
10/13	83.39	02/23	57.57	05/18	57.45	08/23	59.26
11/15	63.08	03/21	57.33	06/21	79.62	09/20	58.63
12/20	66.83						
Well 029N004W11K01M Site No. 402245122165201							
Highest water level 11.96 ft, Oct. 13, 1982; lowest 26.43 ft, Sept. 15, 1982.							
09/15/82	26.43	01/25/83	21.18	04/11/83	22.73	07/21/83	20.87
10/13	11.96	02/23	19.73	05/16	21.97	08/23	22.80
11/15	21.64	03/21	17.69	06/21	P19.24	09/20	22.91
12/20	19.46						

Table 3.--Water levels in wells--Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level

Well 029N004W13M01M Site No. 402158122161801

Highest water level 19.04 ft, Mar. 22, 1983; lowest 27.31 ft, Dec. 28, 1982.

09/15/82	23.50	12/28/82	27.31	03/22/83	19.04	07/26/83	21.82
10/13	23.52	01/25/83	22.14	04/12	22.50	08/24	23.97
11/17	23.18	02/23	20.19	05/20	20.72	09/21	26.38

Well 029N004W15K01M Site No. 402203122175401

Highest water level 8.50 ft, Jan. 25, 1983; lowest 14.95 ft, Sept. 21, 1983.

10/25/82	10.68	01/25/83	8.50	04/12/83	10.93	07/26/83	9.54
11/17	12.97	02/24	9.29	05/20	11.55	08/24	9.45
12/28	9.34	03/22	8.95	06/23	9.94	09/21	14.95

Well 029N004W16P02M Site No. 402140122192801

Highest water level 28.37 ft, Mar. 22, 1983; lowest 38.62 ft, Sept. 21, 1983.

09/17/82	34.29	01/27/83	30.28	04/12/83	29.87	07/26/83	35.78
10/15	33.93	02/24	29.29	05/20	32.12	08/24	35.23
11/17	37.47	03/22	28.37	06/23	32.82	09/21	38.62
12/28	34.48						

Well 029N004W18J01M Site No. 402201122210201

Highest water level 27.83 ft, Mar. 23, 1983; lowest 38.54 ft, Sept. 26, 1983.

09/13/82	35.26	12/29/82	30.95	04/12/83	28.56	07/27/83	31.89
10/15	35.24	02/24/83	30.67	05/18	28.27	08/25	32.13
11/18	38.33	03/23	27.83	06/24	30.60	09/26	38.54

Well 029N004W19A01M Site No. 402131122210501

Highest water level 27.00 ft, Mar. 23, 1983; lowest 37.49 ft, Sept. 13, 1982.

09/13/82	37.49	12/29/82	34.15	04/12/83	31.70	07/27/83	34.85
10/14	35.23	02/24/83	31.96	05/18	32.09	08/25	33.61
11/16	35.42	03/23	27.00	06/24	36.54	09/26	35.45

Well 029N004W19J01M Site No. 402104122210001

Highest water level 23.91 ft, Mar. 22, 1983; lowest 31.69 ft, Sept. 16, 1982.

09/16/82	31.69	01/27/83	26.22	04/13/83	23.93	07/26/83	30.67
10/15	31.12	02/24	23.93	05/20	24.97	08/24	29.19
11/17	29.77	03/22	23.91	06/23	28.22	09/21	28.85
12/28	26.86						

Table 3.--Water levels in wells--Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Well 029N004W19N01M Site No. 402051122215801							
Highest water level 25.54 ft, May 20, 1983; lowest 37.48 ft, Sept. 13, 1982.							
09/13/82	37.48	12/29/82	29.31	04/12/83	27.05	07/27/83	29.56
10/14	31.44	02/24/83	26.83	05/20	25.54	08/25	31.39
11/18	30.20	03/23	25.72	06/24	29.30	09/26	32.65
Well 029N004W19N02M Site No. 402051122215802							
Highest water level 25.01 ft, May 20, 1983; lowest 43.27 ft, Sept. 13, 1982.							
09/13/82	43.27	12/29/82	29.68	04/12/83	26.73	07/27/83	30.55
10/14	31.67	02/25/83	27.32	05/20	25.01	08/25	32.17
11/18	30.57	03/23	26.19	06/24	30.39	09/26	32.37
Well 029N004W19R02M Site No. 402057122210801							
Highest water level 57.50 ft, Mar. 22, 1983; lowest 69.32 ft, July 26, 1983.							
10/15/82	63.08	02/24/83	62.50	05/16/83	60.45	08/24/83	61.03
11/17	62.45	03/22	57.50	06/23	66.11	09/21	62.12
12/28	60.95	04/13	57.72	07/26	69.32		
Well 029N004W20B01M Site No. 402135122201701							
Highest water level 40.68 ft, May 18, 1983; lowest 45.6 ft, Sept. 17, 1982.							
09/17/82	45.6	01/27/83	42.29	04/12/83	41.45	07/26/83	43.49
10/14	44.96	02/24	41.47	05/18	40.68	08/24	43.27
11/17	43.96	03/22	40.78	06/23	42.31	09/21	44.69
12/28	43.34						
Well 029N004W21N03M Site No. 402050122194201							
Highest water level 97.10 ft, June 23, 1983; lowest 114.28 ft, May 20, 1983.							
09/17/82	98.53	01/27/83	102.70	04/12/83	P115.26	07/26/83	104.79
10/25	98.79	02/24	103.57	05/20	114.28	08/24	106.21
11/17	98.59	03/22	106.30	06/23	97.10	09/21	106.85
12/28	103.11						
Well 029N004W22C02M Site No. 402131122181501							
Highest water level 91.04 ft, Mar. 22, 1983; lowest 98.13 ft, Nov. 17, 1982.							
10/25/82	96.77	01/25/83	97.56	04/12/83	96.02	07/26/83	95.24
11/17	98.13	02/24	97.39	05/20	94.47	08/24	94.96
12/28	95.68	03/22	91.04	06/23	93.81	09/21	96.18

Table 3.--Water levels in wells--Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level

Well 029N004W23M01M Site No. 402102122171601

Highest water level 61.72 ft, Mar. 22, 1983; lowest 66.88 ft, Nov. 17, 1982.

09/17/82	65.52	01/25/83	62.38	04/12/83	63.21	07/26/83	63.42
10/14	65.96	02/24	62.32	05/20	66.33	08/24	65.82
11/17	66.88	03/22	61.72	06/23	62.61	09/21	64.98
12/28	63.90						

Well 029N004W28F01M Site No. 402025122192601

Highest water level 32.24 ft, Sept. 17, 1982; lowest 47.65 ft, Nov. 17, 1982.

09/17/82	32.24	01/27/83	43.04	04/12/83	34.71	07/26/83	36.96
10/25	42.80	02/24	38.03	05/20	37.38	08/24	37.17
11/17	47.65	03/22	35.42	06/23	35.17	09/21	37.82
12/28	43.54						

Well 029N004W29M01M Site No. 402011122205101

Highest water level 127.74 ft, Apr. 13, 1983; lowest 137.63 ft, Aug. 24, 1983.

09/17/82	133.35	12/28/82	130.54	04/13/83	127.74	07/26/83	P139.38
10/15	132.38	02/24/83	128.28	05/20	123.02	08/24	137.63
11/17	131.49	03/22	128.44	06/23	P138.23	09/21	130.97

Well 029N004W30M01M Site No. 402016122215801

Highest water level 27.65 ft, Sept. 16, 1982; lowest 36.4 ft, Oct. 15, 1982.

09/16/82	27.65	12/28/82	33.77	04/13/83	29.32	07/26/83	35.40
10/15	36.4	02/25/83	29.91	05/16	29.86	08/24	33.96
11/17	35.7	03/22	28.14	06/23	31.81	09/21	34.27

Well 029N004W30P01M Site No. 401959122213201

Highest water level 115.88 ft, Nov. 17, 1982; lowest 132.49 ft, Sept. 21, 1983.

10/15/82	118.79	12/28/82	125.29	03/22/83	127.99	09/21/83	132.49
11/17	115.88	02/25/83	124.84				

Well 029N004W32M01M Site No. 401920122204301

Highest water level 117.31 ft, June 23, 1983; lowest 130.74 ft, May 16, 1983.

09/16/82	122.10	12/28/82	127.91	04/13/83	128.09	07/26/83	121.38
10/26	122.66	02/25/83	126.56	05/16	130.74	08/24	119.29
11/17	123.94	03/22	123.91	06/23	117.31	09/21	127.74

Well 029N005W01D02M Site No. 402401122225501

Highest water level 109.38 ft, Nov. 16, 1982; lowest 114.80 ft, Sept. 14, 1982.

09/14/82	114.80	10/13/82	110.93	11/16/82	109.38	06/25/83	112.06

Table 3.--Water levels in wells--Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Well 029N005W01L01M Site No. 402344122224501							
Highest water level 92.63 ft, Apr. 11, 1983; lowest 108.08 ft, Sept. 20, 1983.							
09/14/82	101.55	12/27/82	95.23	04/11/83	92.63	07/21/83	98.40
10/13	97.73	02/23/83	96.67	05/18	95.33	08/23	103.27
11/16	96.11	03/21	92.81	06/21	97.70	09/20	108.08
Well 029N005W01N01M Site No. 402320122225601							
Highest water level 80.71 ft, Apr. 11, 1983; lowest 97.53 ft, Sept. 20, 1983.							
09/14/82	89.98	12/27/82	83.70	04/11/83	80.71	07/21/83	92.33
10/13	87.08	02/23/83	81.98	05/18	82.46	08/23	89.17
11/16	86.57	03/21	80.95	06/21	85.71	09/20	97.53
Well 029N005W07B02M Site No. 402306122281601							
Highest water level 40.02 ft, Mar. 22, 1983; lowest 51.37 ft, Oct. 14, 1982.							
09/14/82	P52.96	12/28/82	48.78	04/12/83	42.21	07/26/83	P50.09
10/14	51.37	02/24/83	42.25	05/18	47.82	08/24	47.04
11/16	47.66	03/22	40.02	06/23	44.66	09/21	47.19
Well 029N005W08A01M Site No. 402310122264301							
Highest water level 50.71 ft, May 18, 1983; lowest 62.27 ft, Nov. 16, 1982.							
09/14/82	56.95	12/27/82	56.94	04/12/83	51.21	07/26/83	51.84
10/14	56.56	02/24/83	58.15	05/18	50.71	08/24	52.18
11/16	62.27	03/22	52.55	06/23	50.76	09/21	52.83
Well 029N005W08B01M Site No. 402317122270301							
Highest water level 56.14 ft, May 18, 1983; lowest 67.84 ft, Dec. 27, 1982.							
09/14/82	63.72	12/27/82	67.84	04/12/83	63.07	07/26/83	57.60
10/14	62.74	02/24/83	59.97	05/18	56.14	08/24	60.12
11/16	67.05	03/22	59.81	06/23	56.52	09/21	63.17
Well 029N005W08L02M Site No. 402249122271901							
Highest water level 32.56 ft, Mar. 23, 1983; lowest 43.90 ft, Sept. 14, 1982.							
09/14/82	43.90	12/27/82	38.82	04/12/83	34.25	07/26/83	39.95
10/14	41.66	02/24/83	38.15	05/18	35.29	08/23	40.86
27	40.21	03/23	32.56	06/23	39.16	09/21	43.44
11/16	42.13						

Table 3.--Water levels in wells--Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Well 029N005W09B01M Site No. 402317122254701							
Highest water level 64.04 ft, Sept. 30, 1983; lowest 68.31 ft, Nov. 16, 1982.							
11/16/82	68.31	07/21/83	67.32	08/11/83	67.44	09/01/83	64.75
12/27	67.45	22	67.47	12	67.44	02	64.85
02/24/83	67.68	23	67.41	13	65.28	03	64.94
03/22	66.72	24	67.39	14	64.87	08	64.78
04/12	66.46	25	67.39	15	64.86	11	65.04
05/19	65.66	26	67.36	16	64.71	12	64.94
06/23	66.69	27	67.36	17	64.60	18	64.75
07/07	67.01	28	67.52	18	64.59	19	64.74
08	66.99	29	67.60	19	64.58	20	64.74
09	67.03	30	67.58	20	64.60	21	64.47
10	67.00	31	67.53	21	64.82	22	64.35
11	66.97	08/01	67.49	22	64.82	23	64.30
12	67.09	02	67.49	23	64.64	24	64.28
13	67.09	03	67.48	24	64.87	25	64.24
14	67.07	04	67.47	25	64.77	26	64.21
15	67.04	05	67.46	26	64.76	27	64.22
16	67.00	06	67.40	27	64.98	28	64.14
17	67.05	07	67.39	28	64.95	29	64.05
18	67.10	08	67.41	29	64.83	30	64.04
19	67.19	09	67.37	30	64.75	10/01	64.06
20	67.21	10	67.39	31	64.72		
Well 029N005W09L01M Site No. 402240122260901							
Highest water level 18.70 ft, Mar. 22, 1983; lowest 27.70 ft, Oct. 14, 1982.							
09/14/82	22.71	12/27/82	25.38	04/12/83	19.51	07/26/83	24.03
10/14	27.70	02/24/83	21.38	05/18	21.68	08/24	26.15
11/16	27.44	03/22	18.70	06/23	22.36	09/21	26.00
Well 029N005W12M01M Site No. 402246122231001							
Highest water level 16.75 ft, Nov. 16, 1982; lowest 31.53 ft, Dec. 27, 1982.							
09/14/82	29.40	12/27/82	31.53	04/11/83	20.88	07/21/83	28.98
10/14	30.01	02/23/83	21.77	05/18	22.22	08/23	27.80
11/16	16.75	03/21	22.50	06/21	25.18	09/20	28.62
Well 029N005W14D01M Site No. 402222122240501							
Highest water level 12.28 ft, Apr. 12, 1983; lowest 24.15 ft, Oct. 15, 1982.							
10/15/82	24.15	02/24/83	15.56	05/20/83	15.07	08/25/83	21.55
11/18	23.57	03/23	13.47	06/24	22.54	09/26	23.23
12/29	22.59	04/12	12.28	07/27	21.58		

Table 3.--Water levels in wells--Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Well 029N005W14F01M Site No. 402204122235501							
Highest water level 17.37 ft, Apr. 12, 1983; lowest 30.44 ft, Sept. 13, 1982.							
09/13/82	30.44	12/29/82	26.37	04/12/83	17.37	07/27/83	28.33
10/15	29.87	02/24/83	21.32	05/18	19.41	08/25	27.60
11/18	28.07	03/23	19.60	06/24	25.29	09/26	26.72
Well 029N005W14N01M Site No. 402145122240901							
Highest water level 40.52 ft, May 20, 1983; lowest 52.44 ft, Dec. 29, 1982.							
09/13/82	50.34	12/29/82	52.44	04/12/83	43.69	07/27/83	45.61
10/15	48.99	02/24/83	46.19	05/20	40.52	08/25	44.22
11/18	49.43	03/23	43.61	06/24	44.14	09/26	44.97
Well 029N005W14R01M Site No. 402147122232201							
Highest water level 96.83 ft, Oct. 15, 1982; lowest 123.62 ft, Dec. 29, 1982.							
09/13/82	120.47	12/29/82	123.62	04/12/83	115.74	07/27/83	112.91
10/15	96.83	02/24/83	120.94	05/19	112.64	08/25	114.73
11/18	122.04	03/23	118.05				
Well 029N005W16P01M Site No. 402137122261501							
Highest water level 29.07 ft, Mar. 23, 1983; lowest 47.24 ft, Sept. 13, 1982.							
09/13/82	47.24	12/29/82	34.22	04/12/83	31.23	07/27/83	34.53
10/15	37.43	02/24/83	30.90	05/19	29.51	08/25	P28.41
11/18	36.23	03/23	29.07	06/24	P38.56	09/26	35.49
Well 029N005W21D01M Site No. 402124122262301							
Highest water level 50.99 ft, May 19, 1983; lowest 58.13 ft, Sept. 13, 1982.							
09/13/82	58.13	12/29/82	57.54	04/12/83	56.51	07/27/83	54.68
10/15	56.06	02/24/83	55.71	05/19	50.99	08/25	53.68
11/18	54.80	03/23	51.99	06/24	53.05	09/26	53.15
Well 029N005W22N01M Site No. 402050122251701							
Highest water level 98.71 ft, Mar. 23, 1983; lowest 180.43 ft, Sept. 17, 1982.							
09/17/82	180.43	12/29/82	109.28	04/12/83	104.18	07/27/83	131.78
10/15	104.27	02/24/83	102.22	05/19	123.83	08/25	133.59
11/18	103.14	03/23	98.71	06/24	127.63	09/26	137.34

Table 3.--Water levels in wells--Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Well 029N005W25L01M Site No. 402010122225101							
Highest water level 20.7 ft, Mar. 23, 1983; lowest 31.72 ft, Sept. 16, 1982.							
09/16/82	31.72	12/28/82	24.38	04/13/83	22.15	07/26/83	24.43
10/15	27.06	02/25/83	22.21	05/17	21.86	08/24	26.22
11/17	27.32	03/23	20.70	06/23	23.34	09/21	27.35
Well 029N005W25R01M Site No. 401959122221701							
Highest water level 36.55 ft, Mar. 23, 1983; lowest 44.97 ft, Dec. 29, 1982.							
09/16/82	43.71	12/29/82	44.97	04/13/83	37.76	07/27/83	43.44
10/15	43.16	02/28/83	41.13	05/17	36.75	08/25	41.28
11/18	42.61	03/23	36.55	06/24	38.06	09/22	42.92
Well 029N005W27N01M Site No. 401957122251501							
Highest water level 22.39 ft, Mar. 23, 1983; lowest 30.68 ft, July 23, 1983.							
09/17/82	27.90	12/29/82	27.53	04/12/83	23.60	07/23/83	30.68
10/15	28.97	02/24/83	23.83	05/19	23.55	08/25	P29.47
11/18	26.89	03/23	22.39	06/24	28.17	09/26	30.58
Well 029N005W28C01M Site No. 402039122261101							
Highest water level 191.59 ft, May 20, 1983; lowest 208.52 ft, Sept. 13, 1982.							
09/13/82	208.52	12/29/82	198.60	04/12/83	202.75	07/27/83	195.76
10/15	197.07	02/24/83	198.18	05/20	191.59	08/25	P208.40
11/18	194.48	03/23	197.33	06/24	P204.63	09/26	194.88
Well 029N005W33A01M Site No. 401942122252903							
Highest water level 44.66 ft, Sept. 26, 1983; lowest 51.11 ft, Aug. 25, 1983.							
07/27/83	47.46	08/25/83	51.11	09/26/83	44.66		
Well 029N005W33A02M Site No. 401942122252902							
Highest water level 47.00 ft, Sept. 26, 1983; lowest 50.70 ft, Aug. 25, 1983.							
07/27/83	49.42	08/25/83	50.70	09/26/83	47.00		

Table 3.--Water levels in wells--Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level

Well 029N005W33A03M Site No. 401942122252901

Highest water level 44.80 ft, Oct. 1, 1983; lowest 60.08 ft, July 13, 1983.

07/13/83	60.08	08/12/83	50.63	08/29/83	47.20	09/15/83	48.06
27	48.25	13	50.61	30	46.88	16	47.50
28	47.84	14	49.62	31	46.65	17	47.06
29	47.61	15	49.19	09/01	46.36	18	46.74
30	47.37	16	48.71	02	46.11	19	46.52
31	47.16	17	48.30	03	45.98	20	46.28
08/01	47.02	18	47.98	04	45.78	21	46.10
02	46.87	19	47.98	05	45.68	22	46.44
03	46.94	20	48.16	06	45.60	23	46.20
04	47.64	21	48.02	07	45.50	24	45.94
05	48.64	22	48.01	08	45.60	25	45.70
06	49.16	23	48.94	09	46.36	26	45.63
07	48.80	24	49.60	10	47.10	27	45.40
08	48.74	25	49.87	11	47.34	28	45.21
09	49.48	26	49.80	12	47.65	29	45.03
10	50.06	27	48.10	13	47.82	30	44.90
11	50.32	28	47.60	14	48.30	10/01	44.80

Well 029N005W33A04M Site No. 401942122253001

Highest water level 38.75 ft, Sept. 26, 1983; lowest 40.68 ft, Aug. 25, 1983.

07/27/83	39.35	08/25/83	40.68	09/26/83	38.75

Well 029N005W33A05M Site No. 401942122253002

Highest water level 35.45 ft, July 27, 1983; lowest 36.78 ft, Sept. 26, 1983.

07/27/83	35.45	08/25/83	35.94	09/26/83	36.78

Well 029N005W33C01M Site No. 401939122261101

Highest water level 50.22 ft, Apr. 13, 1983; lowest 63.27 ft, Aug. 25, 1983.

09/16/82	59.28	12/28/82	55.23	04/13/83	50.22	07/27/83	56.39
10/15	56.48	02/25/83	53.60	05/17	52.69	08/25	63.27
11/17	56.78	03/23	52.92	06/24	57.61	09/26	62.01

Well 029N005W33F02M Site No. 401927122260101

Highest water level 57.06 ft, Mar. 23, 1983; lowest 69.44 ft, Aug. 25, 1983.

09/16/82	66.49	12/28/82	60.91	04/13/83	57.46	07/27/83	64.81
10/15	64.15	02/25/83	59.63	05/20	60.78	08/25	69.44
11/17	67.35	03/23	57.06	06/24	64.18	09/26	68.61

Table 3.--Water levels in wells--Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Well 029N005W34B01M Site No. 401951122244901							
Highest water level 12.12 ft, Mar. 23, 1983; lowest 25.78 ft, Sept. 16, 1982.							
09/16/82	25.78	12/28/82	17.96	04/13/83	12.97	06/24/83	21.20
10/15	22.49	02/25/83	14.50	05/20	15.46	07/27	23.34
11/17	19.80	03/23	12.12				
Well 029N005W34D02M Site No. 401945122252201							
Highest water level 28.54 ft, Mar. 23, 1983; lowest 38.00 ft, July 27, 1983.							
09/16/82	34.65	12/28/82	32.57	04/13/83	30.20	07/27/83	38.00
10/15	34.36	02/25/83	32.62	05/20	30.78	08/25	32.74
11/17	36.51	03/23	28.54	06/24	P36.15	09/26	32.91
Well 029N005W34M01M Site No. 401919122251601							
Highest water level 118.60 ft, Apr. 13, 1983; lowest 133.90 ft, Dec. 28, 1982.							
09/16/82	121.82	12/28/82	133.90	04/13/83	118.60	07/27/83	129.52
10/15	128.19	02/25/83	120.56	05/17	122.65	08/25	127.58
11/17	132.98	03/23	119.59	06/24	125.52	09/26	127.12
Well 029N005W35E01M Site No. 401928122241801							
Highest water level 132.14 ft, Sept. 26, 1983; lowest 144.03 ft, July 27, 1983.							
09/16/82	134.75	12/28/82	137.45	04/13/83	P143.64	07/27/83	144.03
10/13	137.24	02/25/83	137.54	05/17	138.17	08/25	142.72
11/17	138.85	03/23	138.75	06/24	143.01	09/26	132.14
Well 029N006W02K01M Site No. 402320122282001							
Highest water level 29.76 ft, Feb. 24, 1983; lowest 52.49 ft, Oct. 14, 1982.							
09/14/82	P53.70	12/27/82	42.67	04/12/83	42.53	07/26/83	33.96
10/14	52.49	02/24/83	29.76	05/18	46.30	08/24	39.81
11/16	41.58	03/22	P38.45	06/23	31.14	09/21	P43.97
Well 029N006W12B01M Site No. 402316122291601							
Highest water level 37.89 ft, Mar. 22, 1983; lowest 42.09 ft, Dec. 28, 1982.							
12/28/82	42.09	04/12/83	38.26	06/23/83	38.35	08/24/83	39.55
02/24/83	40.14	05/18	38.13	07/26	39.05	09/21	39.13
03/22	37.89						

Table 3.--Water levels in wells--Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Well 029N006W12B02M Site No. 402316122291501							
Highest water level 37.31 ft, Mar. 22, 1983; lowest 39.12 ft, Dec. 28, 1982.							
12/28/82	39.12	07/25/83	38.19	08/17/83	38.40	09/09/83	38.49
02/24/83	38.06	26	38.21	18	38.41	10	38.50
03/22	37.31	27	38.22	19	38.43	11	38.50
04/12	37.75	28	38.23	20	38.46	12	38.50
05/19	37.69	29	38.24	21	38.47	13	38.50
06/23	38.34	30	38.26	22	38.48	14	38.51
07/07	38.04	31	38.26	23	38.48	15	38.52
08	38.06	08/01	38.26	24	38.48	16	38.53
09	38.09	02	38.28	25	38.48	17	38.53
10	38.09	03	38.30	26	38.48	18	38.54
11	38.09	04	38.31	27	38.48	19	38.56
12	38.08	05	38.33	28	38.48	20	38.57
13	38.00	06	38.33	29	38.48	21	38.71
14	38.08	07	38.32	30	38.47	22	38.71
15	38.08	08	38.33	31	38.47	23	38.70
16	38.08	09	38.33	09/01	38.48	24	38.69
17	38.08	10	38.34	02	38.48	25	38.69
18	38.10	11	38.37	03	38.48	26	38.69
19	38.15	12	38.38	04	38.48	27	38.70
20	38.18	13	38.38	05	38.47	28	38.69
21	38.18	14	38.38	06	38.48	29	38.67
22	38.17	15	38.39	07	38.48	30	38.66
23	38.18	16	38.40	08	38.49	10/01	38.69
24	38.18						
Well 029N006W12B03M Site No. 402316122291401							
Highest water level 37.76 ft, Mar. 22, 1983; lowest 39.34 ft, Dec. 28, 1982.							
12/28/82	39.34	04/12/83	37.89	06/23/83	38.10	08/24/83	38.65
02/24/83	38.25	05/19	37.84	07/26	38.38	09/21	38.88
03/22	37.76						
Well 029N006W12B04M Site No. 402316122291301							
Highest water level 20.46 ft, Apr. 12, 1983; lowest 27.67 ft, Dec. 28, 1982.							
12/28/82	27.67	04/12/83	20.46	06/23/83	22.51	08/24/83	25.54
02/24/83	21.83	05/19	20.94	07/26	24.18	09/21	26.58
03/22	21.73						
Well 029N006W12B05M Site No. 402316122291201							
Highest water level 8.54 ft, Mar. 22, 1983; lowest 22.04 ft, Dec. 28, 1982.							
12/28/82	22.04	04/12/83	9.56	06/23/83	13.72	08/24/83	19.72
02/24/83	9.14	05/19	10.11	07/26	17.24	09/21	21.61
03/22	8.54						

Table 3.--Water levels in wells--Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Well 030N003W29M01M Site No. 402533122140001							
Highest water level 34.26 ft, Mar. 21, 1983; lowest 38.06 ft, July 21, 1983.							
09/15/82	36.60	01/25/83	38.02	04/11/83	34.44	07/21/83	38.06
10/13	37.23	02/23	37.44	05/16	35.49	08/23	36.03
11/15	37.71	03/21	34.28	06/21	35.87	09/20	36.25
12/20	36.14						
Well 030N003W31P02M Site No. 402425122145101							
Highest water level 116.53 ft, June 21, 1983; lowest 124.31 ft, Sept. 15, 1982.							
09/15/82	124.31	01/25/83	117.46	04/11/83	117.86	07/21/83	118.27
10/13	118.54	02/23	117.80	05/16	116.86	08/23	117.33
11/15	118.67	03/21	117.46	06/21	116.53	09/20	117.72
12/27	117.56						
Well 030N003W32P01M Site No. 402418122134301							
Highest water level 40.26 ft, Mar. 21, 1983; lowest 43.43 ft, Sept. 15, 1982.							
09/15/82	43.43	01/25/83	42.80	04/11/83	40.96	07/21/83	42.61
10/13	42.58	02/23	42.67	05/16	42.06	08/23	43.27
11/15	42.58	03/21	40.26	06/21	42.24	09/20	43.17
12/20	40.65						
Well 030N004W20F01M Site No. 402635122202701							
Highest water level 220.79 ft, Sept. 14, 1982; lowest 237.25 ft, Jan. 25, 1983.							
09/14/82	220.79	01/25/83	237.25	04/11/83	223.63	07/21/83	232.82
10/13	228.03	02/23	227.16	05/17	235.70	08/23	233.68
11/15	233.57	03/21	222.79	06/21	227.25	09/20	228.76
12/27	228.06						
Well 030N004W26F01M Site No. 402534122165701							
Highest water level 225.12 ft, Apr. 11, 1983; lowest 241.36 ft, Sept. 14, 1982.							
09/14/82	241.36	01/25/83	233.68	04/11/83	225.12	07/21/83	229.71
10/13	230.90	02/23	233.32	05/17	232.32	08/23	232.25
11/15	240.09	03/21	230.61	06/21	228.17	09/20	230.30
12/27	226.10						
Well 030N004W33D01M Site No. 402457122194501							
Highest water level 291.84 ft, Sept. 14, 1982; lowest 315.22 ft, Aug. 23, 1983.							
09/14/82	291.84	12/27/82	295.68	03/21/83	297.50	08/23/83	315.22
10/13	294.19	01/25/83	295.98	04/11	P308.09	09/20	309.71
11/15	297.87	02/23	297.33	05/17	312.60		

Table 3.--Water levels in wells--Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Well 030N004W35C01M Site No. 402505122170401							
Highest water level 266.35 ft, Apr. 11, 1983; lowest 285.33 ft, May 17, 1983.							
09/14/82	273.84	01/25/83	272.32	04/11/83	266.85	07/21/83	269.73
10/13	271.59	02/23	270.12	05/17	285.33	08/23	272.21
11/15	271.18	03/21	267.40	06/21	269.46	09/20	274.03
12/27	269.46						
Well 030N005W21K01M Site No. 402610122260001							
Highest water level 270.32 ft, Sept. 20, 1983; lowest 284.60 ft, May 16, 1983.							
09/17/82	279.24	02/23/83	272.33	05/16/83	284.60	08/23/83	281.72
10/13	273.24	03/21	270.64	06/21	283.28	09/20	270.32
11/15	272.63	04/11	271.93	07/21	278.78		
Well 030N005W28B01M Site No. 402553122255101							
Highest water level 205.17 ft, Aug. 23, 1983; lowest 225.37 ft, Sept. 17, 1982.							
09/17/82	225.37	01/25/83	206.17	04/11/83	208.28	07/21/83	214.21
10/13	213.09	02/23	207.59	05/19	205.19	08/23	205.17
11/15	218.48	03/21	206.72	06/21	209.27	09/20	208.28
12/27	208.02						
Well 030N005W34R01M Site No. 402414122242501							
Highest water level 191.64 ft, Apr. 11, 1983; lowest 203.77 ft, Sept. 20, 1983.							
09/17/82	196.70	01/25/83	198.24	04/11/83	191.64	07/21/83	201.12
10/13	196.36	02/23	197.10	05/17	196.66	08/23	196.58
11/15	203.01	03/21	196.46	06/21	192.21	09/20	203.77
12/27	193.79						
Well 030N005W35C01M Site No. 402457122235101							
Highest water level 124.85 ft, May 17, 1983; lowest, 150.40 ft, Oct. 13, 1982.							
09/17/82	145.01	12/27/82	135.48	03/21/83	136.42	06/21/83	141.86
10/13	150.40	01/25/83	135.94	04/11	137.70	08/23	144.29
11/15	144.32	02/23	135.78	05/17	124.85	09/20	144.04
Well 030N006W05G01M Site No. 402910122335101							
Highest water level 2.91 ft, Mar. 22, 1983; lowest 40.37 ft, Sept. 14, 1982.							
09/14/82	40.37	12/28/82	31.38	04/12/83	37.47	07/26/83	14.44
10/14	17.08	02/24/83	7.54	05/19	9.22	08/24	15.07
11/16	18.24	03/22	2.91	06/23	16.98	09/21	16.86

Table 3.--Water levels in wells--Continued

Date	Water level	Date	Water level	Date	Water level	Date	Water level

Well 030N006W09J01M Site No. 402758122322201

Highest water level 96.97 ft, May 18, 1983; lowest 111.18 ft, Oct. 14, 1982.

09/14/82	107.00	12/28/82	105.75	04/12/83	102.89	07/26/83	101.61
10/14	111.18	02/24/83	105.55	05/18	96.97	08/24	102.38
11/16	106.97	03/22	105.48	06/23	97.14	09/21	105.18

Well 030N006W10K01M Site No. 402753122313801

Highest water level 2.49 ft, Mar. 22, 1983; lowest 6.24 ft, Sept. 14, 1982.

09/14/82	6.24	12/28/82	3.16	04/12/83	3.51	07/26/83	4.61
10/14	5.70	02/24/83	2.85	05/18	3.52	08/24	5.64
11/16	4.59	03/22	2.49	06/23	3.82	09/21	5.56

Well 030N006W10K02M Site No. 402753122313802

Highest water level 0.00 ft, Dec. 28, 1982; lowest 6.87 ft, Sept. 14, 1982.

09/14/82	6.87	12/28/82	0.00	05/18/83	0.1	08/24/83	1.84
10/14	.74	02/24/83	.98	07/26	.9	09/21	2.14
11/16	.63						

Well 030N006W15P01M Site No. 402654122314601

Highest water level 72.76 ft, Mar. 22, 1983; lowest 97.20 ft, June 23, 1983.

09/14/82	86.41	12/28/82	79.69	04/12/83	76.02	07/26/83	95.80
10/14	93.02	02/24/83	74.68	05/18	95.33	08/24	83.86
11/16	87.14	03/22	72.76	06/23	97.20	09/21	93.17

Well 030N007W12Q01M Site No. 402739122355701

Highest water level 25.64 ft, Mar. 22, 1983; lowest 50.23 ft, Nov. 16, 1982.

09/14/82	42.37	12/28/82	47.77	04/12/83	26.25	07/26/83	35.89
10/14	48.69	02/24/83	33.60	05/19	25.86	08/24	38.35
11/16	50.23	03/22	25.64	06/23	30.92	09/21	43.69

Table 4.--Chemical analyses of water from wells

[µS, microsiemens per centimeter at 25°C; °C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than. The analysis of each sample is displayed as one line on two consecutive pages]

Date of sample	Depth of well, total (feet)	Specific conductance (µS)	pH (standard units)	Temperature (°C)	Hardness (mg/L as $CaCO_3$)	Hardness, noncarbonate (mg/L $CaCO_3$)	Calcium, dissolved (mg/L as CA)	Magnesium, dissolved (mg/L as MG)	Sodium dissolved (mg/L as NA)	Percent sodium	Sodium adsorption ratio (SAR)	Potassium, dissolved (mg/L as K)
					028N004W09C01M							
10/27/82	240	218	7.9	16.0	78	0	16	9.3	18	33	0.9	1.3
05/18/83	240	225	7.4	20.5	83	0	17	9.8	17	30	.8	1.2
					028N005W01P01M							
10/27/82	343	381	7.4	15.5	170	0	29	24	18	19	.6	.8
05/17/83	343	401	7.1	20.0	170	1	29	24	18	19	.6	.7
					028N005W05G01M							
10/26/82	220	346	7.6	19.0	140	3	27	18	18	22	.7	.8
05/17/83	220	407	7.5	17.0	150	7	29	18	18	21	.7	.8
					028N005W09F01M							
10/27/82	268	327	7.9	17.5	140	2	28	16	17	21	.7	1.0
05/18/83	268	340	7.6	18.5	140	0	30	16	17	21	.6	.8
					028N005W10B01M							
10/27/82	380	306	8.1	15.5	130	0	27	16	18	23	.7	.7
05/18/83	380	320	8.0	18.5	140	0	28	16	17	21	.7	.7
					028N005W11D01M							
10/27/82	454	312	8.1	17.5	130	0	28	14	19	24	.8	1.0
05/17/83	454	329	8.0	20.5	130	0	29	15	18	22	.7	1.0

Table 4.--Chemical analyses of water from wells--Continued

Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as CL)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SIO_2)	Solids, residue at 180°C, dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)	Aluminum, dissolved (µg/L as AL)	Arsenic, dissolved (µg/L as AS)	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as FE)	Manganese, dissolved (µg/L as MN)
					028N004W09C01M							
110	<5.0	3.2	0.2	37	150	---	0.65	<10	1	20	50	22
110	3.0	3.7	.2	44	149	162	1.6	10	2	--	6	<1
					028N005W01P01M							
185	<5.0	10	.2	20	241	---	1.7	<10	1	10	150	2
170	5.0	17	.2	51	241	247	2.4	<10	1	--	8	3
					028N005W05G01M							
139	15	16	.2	38	221	217	.95	<10	1	40	10	2
140	12	18	.2	36	216	216	.77	<10	1	--	7	4
					028N005W09F01M							
134	13	14	.1	31	209	201	.25	<10	1	50	5	5
140	11	16	.1	31	194	206	.20	10	<1	--	5	2
					028N005W10B01M							
153	<5.0	8.9	.1	32	194	---	.33	20	1	50	6	2
150	5.0	11	<.1	32	182	200	.30	10	1	--	3	2
					028N005W11D01M							
146	6.0	10	.1	36	206	202	.35	<10	1	50	170	9
150	6.0	13	.1	35	196	207	.35	<10	1	--	5	<1

Table 4.--Chemical analyses of water from wells--Continued

Date of sample	Depth of well, total (feet)	Specific conductance (µS)	pH (standard units)	Temperature (°C)	Hardness (mg/L as $CaCO_3$)	Hardness, noncarbonate (mg/L $CaCO_3$)	Calcium, dissolved (mg/L as CA)	Magnesium, dissolved (mg/L as MG)	Sodium dissolved (mg/L as NA)	Percent sodium	Sodium adsorption ratio (SAR)	Potassium, dissolved (mg/L as K)
					028N005W13A01M							
10/27/82	299	283	8.1	20.0	130	0	26	15	15	20	0.6	0.7
05/18/83	299	289	8.0	20.0	130	0	27	15	15	20	.6	.8
					028N005W14F01M							
10/27/82	340	290	8.1	19.5	140	0	27	17	12	16	.5	.7
05/18/83	340	298	8.0	19.5	140	0	27	17	12	16	.5	.8
					029N003W04N01M							
10/26/82	100	423	7.0	17.0	180	28	30	25	20	19	.7	3.0
05/16/83	100	412	7.4	19.0	170	27	29	24	18	18	.6	3.0
					029N003W06L01M							
10/26/82	89	160	7.3	16.0	56	0	9.0	8.1	12	31	.7	.9
05/17/83	89	159	7.3	17.0	58	0	9.4	8.5	13	32	.8	1.1
					029N003W07D01M							
10/26/82	112	255	7.1	16.5	99	0	15	15	17	27	.8	.5
					029N004W02K01M							
10/26/82	151	164	7.2	16.0	53	0	8.9	7.4	14	36	.9	.5
05/17/83	151	165	7.3	17.5	56	0	9.3	8.0	14	35	.8	.7
					029N004W04Q01M							
10/26/82	140	180	7.4	20.0	60	0	11	7.9	14	33	.8	.6
05/17/83	140	165	6.8	22.5	54	0	9.5	7.4	13	34	.8	.6

Table 4.--Chemical analyses of water from wells--Continued

Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as CL)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SIO_2)	Solids, residue at 180°C, dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)	Aluminum, dissolved (µg/L as AL)	Arsenic, dissolved (µg/L as AS)	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as FE)	Manganese, dissolved (µg/L as MN)
					028N005W13A01M							
148	<5.0	4.0	0.1	31	181	---	0.67	<10	1	40	9	34
150	.7	3.8	.1	32	169	184	.77	10	1	--	7	14
					028N005W14F01M							
162	<5.0	3.7	.2	36	188	---	.75	<10	1	20	13	5
160	.7	3.7	.2	35	176	192	.71	10	2	--	7	2
					029N003W04N01M							
150	23	23	.2	74	304	289	5.4	<10	1	10	4	1
---	17	20	.2	74	277	272	4.4	<10	1	--	7	3
					029N003W06L01M							
76	<5.0	1.9	.2	43	117	---	.60	<10	1	<10	<3	<1
77	3.6	1.9	.2	42	114	126	.54	<10	1	--	6	2
					029N003W07D01M							
117	7.0	4.0	.2	43	161	172	1.6	<10	1	<10	<3	4
					029N004W02K01M							
72	<5.0	3.1	.2	43	117	---	.93	<10	1	<10	6	1
84	2.2	2.9	.2	43	119	131	.94	<10	1	--	35	4
					029N004W04Q01M							
---	<5.0	6.9	.2	55	145	---	1.2	<10	1	<10	12	3
69	3.0	4.7	.2	55	132	135	1.3	<10	1	--	14	5

Table 4.--Chemical analyses of water from wells--Continued

Date of sample	Depth of well, total (feet)	Specific conductance (µS)	pH (standard units)	Temperature (°C)	Hardness (mg/L as $CaCO_3$)	Hardness non-carbonate (mg/L $CaCO_3$)	Calcium, dissolved (mg/L as CA)	Magnesium, dissolved (mg/L as MG)	Sodium dissolved (mg/L as NA)	Percent sodium	Sodium adsorption ratio (SAR)	Potassium, dissolved (mg/L as K)
					029N004W07K01M							
10/27/82	100	265	7.2	15.5	120	2	21	17	11	16	0.4	0.8
05/18/83	100	268	7.2	21.5	120	0	21	16	11	17	.5	.8
					029N004W08C01M							
10/26/82	200	261	7.4	19.5	100	0	21	12	14	23	.6	.6
05/17/83	200	225	6.8	21.0	90	0	18	11	12	22	.6	.6
					029N004W10H01M							
10/26/82	144	230	7.4	17.5	92	0	17	12	13	23	.6	.6
05/17/83	144	227	7.2	18.0	85	0	16	11	15	28	.7	.6
					029N004W11K01M							
10/26/82	200	191	7.2	17.5	70	0	13	9.0	11	25	.6	.6
05/16/83	200	185	7.6	19.0	71	0	13	9.3	11	25	.6	.7
					029N004W14J01M							
10/26/82	498	151	7.8	16.5	57	0	12	6.6	9.8	27	.6	.7
05/16/83	498	180	7.4	16.5	62	0	12	7.8	10	26	.6	.7
					029N004W18J01M							
10/27/82	150	166	7.5	18.5	57	0	9.2	8.2	13	33	.8	.5
05/18/83	150	213	6.6	18.5	94	4	13	15	7.1	14	.3	.4
					029N004W19A01M							
10/27/82	46	307	7.0	18.0	120	6	26	13	13	19	.5	.9
05/18/83	46	313	6.5	17.5	110	3	19	16	20	28	.8	1.1

Table 4.--Chemical analyses of water from wells--Continued

Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as CL)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SIO_2)	Solids, residue at 180°C, dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)	Aluminum, dissolved (µg/L as AL)	Arsenic, dissolved (µg/L as AS)	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as FE)	Manganese, dissolved (µg/L as MN)
					029N004W07K01M							
121	7.0	3.0	<0.1	42	171	175	1.5	<10	1	<10	4	2
130	7.7	3.0	<.1	40	171	178	1.4	<10	1	--	6	1
					029N004W08C01M							
---	6.0	5.5	.2	49	172	175	3.4	<10	1	<10	14	2
100	6.3	3.8	.2	49	164	161	2.9	<10	1	--	11	2
					029N004W10H01M							
---	6.0	3.8	.2	45	160	163	1.5	<10	<1	--	19	2
120	5.1	3.8	.2	47	170	171	1.5	<10	<1	--	<3	<1
					029N004W11K01M							
79	<5.0	5.6	.2	42	129	---	.90	<10	1	20	<3	<1
85	4.0	5.5	.2	41	126	136	.90	<10	1	--	8	7
					029N004W14J01M							
69	<5.0	3.4	.1	17	112	---	.31	20	1	10	160	6
73	3.2	3.9	.1	38	118	120	.68	<10	1	--	3	2
					029N004W18J01M							
74	<5.0	2.6	.1	53	130	---	1.0	<10	1	<10	3	<1
90	5.4	3.9	<.1	42	141	141	3.4	10	<1	--	5	1
					029N004W19A01M							
113	11	10	<.1	41	187	183	2.4	<10	<1	30	4	1
110	13	18	<.1	33	187	186	3.9	10	<1	--	9	8

Table 4.--Chemical analyses of water from wells--Continued

Date of sample	Depth of well, total (feet)	Specific conductance (µS)	pH (standard units)	Temperature (°C)	Hardness (mg/L as $CaCO_3$)	Hardness, noncarbonate (mg/L $CaCO_3$)	Calcium, dissolved (mg/L as CA)	Magnesium, dissolved (mg/L as MG)	Sodium dissolved (mg/L as NA)	Percent sodium	Sodium adsorption ratio (SAR)	Potassium, dissolved (mg/L as K)
					029N004W19R02M							
10/26/82	175	299	7.2	16.5	130	14	29	14	13	18	0.5	0.9
05/16/83	175	365	7.3	----	140	15	31	14	13	17	.5	.9
					029N004W20B01M							
05/18/83	94	230	7.4	18.5	96	3	24	8.8	11	20	.5	.8
					029N004W21N03M							
10/27/82	135	75	6.8	20.0	18	0	3.3	2.3	7.7	48	.8	.4
05/18/83	135	58	7.2	18.0	16	0	3.1	2.0	7.2	49	.8	.4
					029N004W22B03M							
10/26/82	100	180	7.2	17.5	75	0	14	9.8	11	24	.6	.7
05/16/83	100	173	7.0	16.0	79	0	15	10	11	23	.6	.6
					029N004W30M01M							
10/26/82	104	155	6.9	18.0	58	8	13	6.2	8.2	23	.5	.6
05/16/83	104	209	6.8	17.5	72	10	16	7.9	9.3	22	.5	.7
					029N004W32M01M							
10/26/82	140	172	7.4	19.0	65	0	14	7.2	12	29	.7	.6
05/16/83	140	207	7.4	20.5	65	0	14	7.2	11	27	.6	.6
					029N005W01D01M							
10/26/82	220	162	7.3	19.0	51	0	10	6.4	17	42	1.1	.6
05/18/83	220	109	7.0	19.5	51	0	10	6.3	16	40	1.0	.6

Table 4.--Chemical analyses of water from wells--Continued

Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as CL)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SIO_2)	Solids, residue at 180°C, dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)	Aluminum, dissolved (µg/L as AL)	Arsenic, dissolved (µg/L as AS)	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as FE)	Manganese, dissolved (µg/L as MN)
					029N004W19R02M							
116	13	13	0.1	38	201	191	1.1	10	<1	40	24	3
120	12	16	.1	37	197	196	1.1	<10	<1	--	27	4
					029N004W20B01M							
93	9.7	8.3	<.1	30	141	149	1.6	<10	1	--	4	<1
					029N004W21N03M							
28	<5.0	1.7	.1	37	76	---	1.6	10	1	<10	7	2
25	.2	1.3	.2	38	70	68	1.8	20	2	--	25	5
					029N004W22B03M							
89	<5.0	3.1	.1	39	142	---	.62	<10	1	10	8	3
83	4.5	3.1	.1	38	131	132	.60	<10	1	--	8	2
					029N004W30M01M							
50	5.0	2.4	<.1	54	141	120	4.3	20	<1	10	6	1
62	6.4	4.1	<.1	55	155	137	4.7	<10	<1	--	5	1
					029N004W32M01M							
85	<5.0	2.2	.2	48	135	---	.70	10	1	10	5	<1
90	1.7	2.4	.2	45	128	136	.72	<10	1	--	6	2
					029N005W01D01M							
---	<5.0	3.4	.1	61	145	---	.57	<10	1	<10	6	2
91	1.0	3.3	<.1	59	135	151	.56	<10	<1	--	24	3

Table 4.--Chemical analyses of water from wells--Continued

Date of sample	Depth of well, total (feet)	Specific conductance (µS)	pH (standard units)	Temperature (°C)	Hardness (mg/L as $CaCO_3$)	Hardness, noncarbonate (mg/L $CaCO_3$)	Calcium, dissolved (mg/L as CA)	Magnesium, dissolved (mg/L as MG)	Sodium dissolved (mg/L as NA)	Percent sodium	Sodium adsorption ratio (SAR)	Potassium, dissolved (mg/L as K)
					029N005W08L02M							
10/27/82	140	326	7.2	17.5	160	0	28	21	11	13	0.4	0.7
05/18/83	140	270	6.7	18.5	130	0	19	20	9.4	14	.4	.5
					029N005W09L01M							
10/25/82	140	---	6.9	18.5	110	0	19	16	11	17	.5	.8
05/18/83	140	251	6.8	20.0	110	3	19	16	11	17	.5	.8
					029N005W14F01M							
10/28/82	120	163	6.4	15.5	66	0	12	8.8	6.5	17	.4	.5
05/18/83	120	163	6.7	18.5	70	0	12	9.7	6.4	16	.3	.6
					029N005W14R01M							
10/28/82	170	225	6.7	17.5	85	1	16	11	11	22	.5	.6
05/19/83	170	215	6.6	19.5	64	3	13	7.6	16	35	.9	.6
					029N005W15A02M							
10/28/82	250	238	7.3	17.5	89	0	16	12	11	21	.5	.6
05/19/83	250	237	7.1	19.0	110	0	19	14	12	20	.5	.7
					029N005W16P01M							
10/28/82	96	290	7.0	14.5	120	8	20	18	11	16	.4	.6
05/19/83	96	338	6.9	16.5	150	7	24	21	12	15	.4	.8
					029N005W21D01M							
10/28/82	130	307	7.2	11.0	130	0	21	19	13	18	.5	.7
05/19/83	130	312	6.9	18.0	140	0	22	20	13	17	.5	.7

Table 4.--Chemical analyses of water from wells--Continued

Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as CL)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SIO_2)	Solids, residue at 180°C, dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)	Aluminum, dissolved (µg/L as AL)	Arsenic, dissolved (µg/L as AS)	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as FE)	Manganese, dissolved (µg/L as MN)
					029N005W08L02M							
166	7.0	3.1	<0.1	49	209	219	0.60	10	<1	<10	8	2
140	7.0	3.8	<.1	52	183	196	.77	<10	<1	--	14	4
					029N005W09L01M							
120	8.0	4.9	.1	47	179	179	2.8	<10	<1	<10	8	11
110	8.7	4.6	<.1	47	173	173	3.2	<10	<1	--	7	1
					029N005W14F01M							
69	<5.0	2.8	<.1	41	118	---	1.3	<10	<1	<10	4	8
73	4.0	2.9	<.1	42	118	122	1.4	10	<1	--	5	6
					029N005W14R01M							
84	6.0	3.3	<.1	50	153	149	3.4	<10	1	<10	5	3
61	6.3	3.8	<.1	57	163	141	6.0	10	<1	--	22	6
					029N005W15A02M							
100	<5.0	3.0	.1	46	147	---	1.2	<10	1	<10	52	6
120	4.9	4.2	.1	49	165	176	2.1	10	1	--	16	1
					029N005W16P01M							
116	10	7.6	<.1	52	192	189	2.9	<10	1	<10	4	3
140	11	9.0	<.1	53	213	215	3.7	10	<1	--	6	3
					029N005W21D01M							
143	5.0	9.4	<.1	50	193	204	.78	10	<1	<10	14	27
140	5.5	9.4	<.1	51	195	206	.84	20	<1	--	6	20

Table 4.--Chemical analyses of water from wells--Continued

Date of sample	Depth of well, total (feet)	Specific conductance (µS)	pH (standard units)	Temperature (°C)	Hardness (mg/L as $CaCO_3$)	Hardness, noncarbonate (mg/L $CaCO_3$)	Calcium, dissolved (mg/L as CA)	Magnesium, dissolved (mg/L as MG)	Sodium dissolved (mg/L as NA)	Percent sodium	Sodium adsorption ratio (SAR)	Potassium, dissolved (mg/L as K)
					029N005W22N01M							
10/28/82	290	205	7.8	14.0	77	0	15	9.7	13	27	0.7	0.7
05/19/83	290	218	7.8	19.5	79	0	15	10	13	26	.7	.7
					029N005W25L01M							
10/26/82	60	387	6.9	17.0	170	9	42	17	15	16	.5	1.0
05/17/83	60	365	6.8	17.0	170	8	39	17	14	15	.5	.9
					029N005W25R01M							
05/17/83	73	177	7.1	16.5	70	0	14	8.5	9.9	23	.5	.6
					029N005W27N01M							
10/28/82	95	325	7.5	17.5	130	18	27	16	15	20	.6	.8
05/19/83	95	361	6.8	18.0	150	37	26	20	15	18	.6	.6
					029N005W33A01M							
06/23/83	614	305	8.2	21.0	75	0	20	6.1	24	21	.6	.8
					029N005W33C01M							
10/26/82	140	310	7.5	17.5	130	0	28	15	16	19	.6	.6
05/17/83	140	370	7.3	17.0	130	4	29	15	15	27	.7	.6
					029N005W34M01M							
10/26/82	204	205	7.7	18.0	81	0	18	8.7	14	34	.9	.6
05/17/83	204	---	7.4	19.0	65	0	14	7.4	16	26	.7	.7
					029N005W35E01M							
10/26/82	240	237	7.7	18.5	94	0	21	10	15	25	.7	.7
05/17/83	240	246	7.4	18.0	96	0	22	10	15	20	.5	.8

Table 4.--Chemical analyses of water from wells--Continued

Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as CL)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SIO_2)	Solids, residue at 180°C, dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)	Aluminum, dissolved (µg/L as AL)	Arsenic, dissolved (µg/L as AS)	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as FE)	Manganese, dissolved (µg/L as MN)
					029N005W22N01M							
102	<5.0	2.7	0.2	46	143	---	0.63	<10	1	<10	8	<1
110	.6	2.6	.2	47	140	155	.65	10	1	--	34	2
					029N005W25L01M							
166	14	15	<.1	44	247	248	1.6	<10	<1	10	10	11
160	14	16	<.1	38	233	235	1.8	<10	<1	--	4	<1
					029N005W25R01M							
77	5.8	5.5	.1	40	127	131	.80	<10	<1	--	7	5
					029N005W27N01M							
115	18	20	.1	31	194	197	1.1	<10	<1	50	9	3
110	16	13	<.1	36	218	193	6.0	10	<1	--	12	3
					029N005W33C01M							
133	9.0	10	.1	35	205	194	.94	<10	1	30	6	<1
130	8.9	12	.1	34	196	193	1.4	<10	1	--	6	<1
					029N005W34M01M							
100	<5.0	2.9	.2	33	139	---	.90	<10	1	20	11	2
140	1.3	2.4	.2	30	123	156	.69	<10	1	--	10	<10
					029N005W35E01M							
113	<5.0	4.1	.2	36	156	---	1.4	<10	1	10	6	1
120	2.9	4.2	.2	35	155	162	1.5	10	1	--	8	1

Table 4.--Chemical analyses of water from wells--Continued

Date of sample	Depth of well, total (feet)	Specific conductance (µS)	pH (standard units)	Temperature (°C)	Hardness (mg/L as $CaCO_3$)	Hardness, noncarbonate (mg/L $CaCO_3$)	Calcium, dissolved (mg/L as CA)	Magnesium, dissolved (mg/L as MG)	Sodium dissolved (mg/L as NA)	Percent sodium	Sodium adsorption ratio (SAR)	Potassium, dissolved (mg/L as K)
					029N005W36J01M							
10/27/82	100	258	7.5	13.0	113	0	22	14	13	20	0.5	0.8
					029N006W02K01M							
10/27/82	100	424	6.8	15.0	189	67	31	27	12	12	.4	.9
05/18/83	100	400	7.1	18.5	180	50	31	25	11	12	.4	.9
					030N003W32P01M							
10/26/82	100	126	6.6	17.0	46	0	9.4	5.4	6.3	23	.4	.6
05/16/83	100	136	7.1	15.5	58	0	12	6.8	6.7	20	.4	.6
					030N004W33D01M							
10/27/82	336	213	7.7	19.5	70	0	13	9.2	18	35	1.0	.8
05/17/83	336	204	7.1	20.0	70	0	13	9.2	17	34	.9	.9
					030N004W35C01M							
10/27/82	300	197	8.0	19.5	58	0	11	7.5	18	40	1.1	.8
05/17/83	300	192	7.4	21.5	59	0	11	7.7	18	39	1.0	.8
					030N005W21K01M							
10/27/82	398	132	7.2	19.0	39	0	7.6	4.8	13	42	.9	.3
05/17/83	398	125	6.8	19.5	40	0	7.8	4.9	13	41	.9	.3
					030N005W34R01M							
10/27/82	271	151	6.9	19.5	47	0	9.0	5.9	13	37	.6	.5
05/17/83	271	140	6.9	20.5	46	0	8.9	5.8	12	36	.8	.5
					030N006W10K02M							
10/27/82	100	197	7.9	14.5	51	0	11	5.8	25	51	1.6	.5
05/18/83	100	222	7.0	21.0	90	0	13	14	16	28	.7	.4

Table 4.--Chemical analyses of water from wells--Continued

Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as CL)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SIO_2)	Solids, residue at 180°C, dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)	Aluminum, dissolved (µg/L as AL)	Arsenic, dissolved (µg/L as AS)	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as FE)	Manganese, dissolved (µg/L as MN)
					029N005W36J01M							
120	<5.0	6.0	0.2	24	177	---	1.8	<10	1	18	89	21
					029N006W02K01M							
122	24	12	<.1	44	266	224	12	<10	<1	10	9	4
130	20	12	<.1	44	247	222	9.2	<10	<1	--	7	2
					030N003W32P01M							
54	6.0	2.0	<.1	22	79	84	.38	<10	<1	30	5	8
---	4.7	2.2	<.1	20	88	92	.70	<10	<1	--	39	16
					030N004W33D01M							
105	<5.0	3.5	.1	51	152	---	.45	<10	3	<10	4	2
89	3.6	3.4	.1	51	148	152	.44	<10	3	--	<3	2
					030N004W35C01M							
97	5.0	2.6	.2	47	137	151	.48	<10	1	10	5	1
100	4.7	2.6	.2	46	139	151	.47	<10	1	--	10	2
					030N005W21K01M							
61	<5.0	2.2	.1	54	116	---	.34	<10	2	<10	5	1
62	.8	2.2	.1	52	112	119	.32	<10	2	--	7	2
					030N005W34R01M							
66	<5.0	2.9	.1	63	131	---	.63	<10	1	<10	6	2
62	3.0	2.8	.1	61	131	132	.60	<10	<1	--	11	4
					030N006W10K02M							
99	<5.0	2.9	.2	42	142	---	.60	<10	<1	50	130	66
120	2.8	1.6	.2	46	149	166	.26	<10	<1	--	50	8

Table 5.--Trace-metal analyses of water from Corps of Engineers test well 029N006W02P01M

[All elements reported in micrograms per liter; <, less than]

Date of sample	Sampling depth (feet)	Cadmium, dissolved (as CD)	Chromium, dissolved (as CR)	Cobalt, dissolved (as CO)	Copper, dissolved (as CU)	Lead, dissolved (as PB)
10/25/82	246	<1	<1	<1	<1	4
10/25/82	176	<1	<1	<1	<1	2
10/26/82	104	2	<1	<1	<1	3

Lithium, dissolved (as LI)	Mercury, dissolved (as MG)	Molybdenum, dissolved (as MO)	Nickel, dissolved (as NI)	Selenium, dissolved (as SE)	Strontium, dissolved (as SR)	Vanadium, dissolved as V)	Zinc, dissolved (as ZN)
10	0.1	8	<1	<1	31	<1.0	12
9	<.1	8	<1	<1	40	<1.0	4
<4	<.1	9	<1	1	72	2.8	4

Table 6.--Chemical analyses of water from streams

[ft^3/s, cubic feet per second; µS, microsiemens per centimeter at 25°C; °C, degrees Celsius; mg/L, milligrams per liter; <, less than. The analysis of each sample is displayed as one line on three consecutive pages]

Date of sample	Time	Streamflow, instantaneous (ft^3/s)	Specific conductance (µS)	pH (standard units)	Temperature (°C)	Oxygen, dissolved (mg/L)	Hardness (mg/L as $CaCO_3$)	Hardness, noncarbonate (mg/L $CaCO_3$)	Calcium, dissolved (mg/L as C)	Magnesium, dissolved (mg/L as MG)	Sodium, dissolved (mg/L as NA)	Percent sodium
402249122121501 Cottonwood Creek above mouth												
05/11/82	1530	864	236	---	20.5	9.3	110	3	24	11	8.1	14
10/06/82	1330	190	273	7.8	17.0	10.2	130	0	27	15	11	15
04/21/83	1220	1,850	212	8.0	16.0	10.2	110	8	25	11	8.2	14
402259122130201 Patterson Creek on J.B. Ranch												
05/10/82	1300	.07	110	7.1	22.5	7.4	41	0	8.1	5.0	5.9	21
10/08/82	1145	1.9	97	7.3	17.0	9.5	35	0	7.1	4.3	5.4	23
04/25/83	1150	6.5	103	6.8	11.5	.0	39	3	7.7	4.9	4.1	18
11376000 Cottonwood Creek near Cottonwood												
05/11/82	1400	896	281	8.1	17.0	9.4	110	6	25	11	7.9	14
10/08/82	0800	672	170	7.4	13.0	9.8	71	0	15	8.2	6.9	17
04/21/83	1015	1,940	212	7.8	14.5	10.1	110	26	25	11	8.1	14
402241122155101 Cottonwood Creek above powerlines												
05/11/82	1015	863	288	8.0	16.0	9.6	99	0	23	10	7.4	14
10/08/82	1000	138	170	7.3	---	8.6	76	0	16	8.8	7.1	17
04/21/83	0915	1,930	225	7.3	13.5	10.2	110	28	25	11	8.3	14
402240122170401 Tributary above I-5, left bank												
05/10/82	1500	1.8	125	7.2	20.5	10.2	47	0	8.9	6.0	6.8	23
10/06/82	1445	11	97	7.6	12.5	10.6	40	0	8.9	4.2	4.4	19
04/21/83	1550	11	75	7.0	14.5	10.6	34	0	6.8	4.2	3.4	17

Table 6.--Chemical analyses of water from streams--Continued

Date of sample	Potassium, dissolved (mg/L as K)	Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as CL)	Fluoride, dissolved (mg/L as F)	Silica, dissolved, (mg/L as SIO_2)	Solids, residue at 180°C dissolved (mg/L)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, NO_2+NO_3 total (mg/L as N)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)
402249122121501 Cottonwood Creek above mouth											
05/11/82	1.0	102	11	4.3	<0.10	18	148	<0.020	<0.10	<0.10	0.120
10/06/82	1.3	147	10	11	.10	19	169	<.020	<.10	<.10	.080
04/21/83	1.2	100	20	3.9	<.10	17	138	<.020	<.10	<.10	<.060
402259122130201 Patterson Creek on J.B. Ranch											
05/10/82	4.9	50	8.0	2.4	<.10	20	103	<.020	<.10	.15	.230
10/08/82	2.7	41	9.0	2.0	<.10	20	77	<.020	<.10	<.10	.090
04/25/83	1.4	36	9.9	1.4	<.10	16	62	.020	.20	.22	.580
11376000 Cottonwood Creek near Cottonwood											
05/11/82	1.0	102	11	4.2	<.10	18	135	<.020	<.10	<.10	.110
10/08/82	1.3	73	7.0	6.4	<.10	19	107	<.020	<.10	.12	<.060
04/21/83	.9	82	20	4.0	<.10	17	140	<.020	<.10	<.10	<.060
402241122155101 Cottonwood Creek above powerlines											
05/11/82	1.1	130	12	4.2	<.10	17	141	<.020	<.10	<.10	.100
10/08/82	1.3	92	7.0	6.3	<.10	18	112	<.020	<.10	<.10	.080
04/21/83	1.0	80	20	15	<.10	17	144	<.020	<.10	<.10	.080
402240122170401 Tributary above I-5, left bank											
05/10/82	1.7	53	5.0	2.6	<.10	16	86	.030	.18	.12	.140
10/06/82	1.1	45	<5.0	1.4	<.10	18	63	<.020	<.10	<.10	.060
04/21/83	.9	34	7.1	1.3	<.10	16	56	<.020	<.10	<.10	<.060

Table 6.--Chemical analyses of water from streams--Continued

Date of sample	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as NH_4)	Nitrogen, ammonia + organic dissolved (mg/L as N)	Phosphorus, total (mg/L as P)	Phosphorus, total (mg/L as PO_4)	Phosphorus, ortho, total (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as FE)	Carbon, organic total (mg/L as C)
			402249122121501 Cottonwood Creek above mouth							
05/11/82	0.100	0.13	0.42	0.010	0.03	0.020	0.020	30	<9	1.2
10/06/82	.080	.10	.30	.010	.03	<.010	<.010	40	10	1.3
04/21/83	<.060	---	.50	.080	.25	.030	.040	30	37	1.4
			402259122130201 Patterson Creek on J.B. Ranch							
05/10/82	.210	.27	1.6	.270	.83	.180	.170	30	92	12
10/08/82	<.060	.08	.70	.060	.18	.040	.040	30	85	5.7
04/25/83	.350	.45	.90	.080	.25	.050	.040	20	140	---
			11376000 Cottonwood Creek near Cottonwood							
05/11/82	.120	.15	.77	<.010	---	.020	.020	30	15	1.1
10/08/82	.530	.68	1.7	.020	.06	.010	<.010	30	37	1.3
04/21/83	<.060	---	.20	.090	.28	.030	.050	20	19	---
			402241122155101 Cottonwood Creek above powerlines							
05/11/82	.190	.24	.62	.010	.03	.020	.020	40	<9	1.1
10/08/82	.070	.09	.40	.020	.06	<.010	<.010	30	25	1.7
04/21/83	.080	.10	1.6	.090	.28	.020	.050	30	22	1.2
			402240122170401 Tributary above I-5, left bank							
05/10/82	.160	.21	1.5	.080	.25	.050	.030	40	46	3.6
10/06/82	<.060	.08	.60	.020	.06	<.010	<.010	30	44	1.6
04/21/83	<.060	---	.40	.080	.25	.030	.050	<10	360	1.8

Table 6.--Chemical analyses of water from streams--Continued

Date of sample	Time	Streamflow, instantaneous (ft^3/s)	Specific conductance (µS)	pH (standard units)	Temperature (°C)	Oxygen, dissolved (mg/L)	Hardness (mg/L as $CaCO_3$)	Hardness, noncarbonate (mg/L $CaCO_3$)	Calcium, dissolved (mg/L as C)	Magnesium, dissolved (mg/L as MG)	Sodium, dissolved (mg/L as NA)	Percent sodium
402226122170501 Tributary at Holiday Ranch												
05/10/82	1630	4.9	111	8.1	21.0	10.2	40	0	8.9	4.4	5.6	22
10/08/82	1430	1.5	115	6.9	16.0	9.3	49	0	9.9	5.9	6.7	22
04/19/83	1445	.29	156	6.9	18.0	12.5	63	0	12	8.1	8.8	23
402242122174901 Ditch No. 1 at Clarks Ranch												
05/20/82	0845	.03	120	7.3	15.0	9.5	55	0	11	6.7	7.0	21
10/05/82	1430	3.3	94	7.4	---	8.5	41	0	8.3	4.9	5.0	19
04/22/83	1040	.98	158	7.8	13.5	10.6	54	1	11	6.5	7.4	22
402249122174301 Ditch No. 2 at Clarks Ranch												
05/20/82	0830	3.3	127	7.2	14.5	8.3	52	0	11	5.9	5.8	19
10/05/82	1500	.39	81	7.5	14.5	9.7	40	0	8.5	4.5	4.8	20
04/22/83	1030	.11	125	7.9	12.0	11.8	51	0	10	6.3	5.8	20
402206122184901 Hooker Creek at Draper Road												
10/07/82	1530	2.0	107	7.9	19.5	11.7	40	0	8.6	4.6	5.5	22
04/25/83	1245	34	77	6.8	15.5	9.7	26	0	5.4	3.1	3.6	22
402229122191801 Cottonwood Creek below South Fork												
05/14/82	0915	810	231	8.0	18.5	9.6	96	0	22	10	7.3	14
10/06/82	1330	34	273	7.8	17.0	10.2	130	8	27	15	11	15
04/22/83	0900	1,900	180	8.0	12.5	10.2	82	5	18	9.0	5.4	12
402225122193901 Tributary below South Fork confluence, left bank												
05/20/82	1130	.39	111	6.7	19.5	7.3	40	0	8.6	4.5	6.0	24
10/05/82	1315	.22	112	6.8	19.5	7.1	44	0	9.4	4.9	6.6	24
04/22/83	0915	25	86	7.4	12.0	---	34	1	6.7	4.3	3.8	19

Table 6.--Chemical analyses of water from streams--Continued

Date of sample	Potassium, dissolved (mg/L as K)	Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as CL)	Fluoride, dissolved (mg/L as F)	Silica, dissolved, (mg/L as SIO_2)	Solids, residue at 180°C dissolved (mg/L)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, NO_2+NO_3 total (mg/L as N)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)
402226122170501 Tributary at Holiday Ranch											
05/10/82	2.7	---	5.0	2.5	<0.10	16	80	<0.020	0.24	0.16	0.120
10/06/82	2.4	---	8.0	2.5	<.10	19	83	<.020	<.10	<.10	.090
04/19/83	1.2	---	8.0	3.4	<.10	13	82	<.020	<.10	<.10	.110
402242122174901 Ditch No. 1 at Clarks Ranch											
05/20/82	2.0	62	6.0	3.4	.10	10	96	<.020	<.10	<.10	.090
10/05/82	4.4	41	8.0	2.6	<.10	19	83	.020	.10	.12	.160
04/22/83	1.6	53	11	4.2	<.10	18	87	<.020	.90	.85	.100
402249122174301 Ditch No. 2 at Clarks Ranch											
05/20/82	2.2	56	7.0	2.5	.10	18	48	<.020	.48	.47	<.060
10/05/82	1.7	44	6.0	1.6	<.10	18	73	<.020	<.10	<.10	.070
04/22/83	.8	50	7.7	2.0	<.10	17	74	<.020	.90	.88	.090
402206122184901 Hooker Creek at Draper Road											
10/07/82	1.3	41	6.0	1.8	<.10	18	73	<.020	<.10	<.10	.100
04/25/83	1.3	28	4.2	2.6	<.10	15	47	<.020	.30	.30	.390
402229122191801 Cottonwood Creek below South Fork											
05/14/82	1.4	97	11	4.3	<.10	18	137	<.020	<.10	<.10	<.060
10/06/82	1.3	121	10	11	.10	19	169	<.020	<.10	<.10	.080
04/22/83	.9	77	13	2.3	<.10	19	107	<.020	<.10	<.10	<.060
402225122193901 Tributary below South Fork confluence, left bank											
05/20/82	1.3	58	6.0	1.8	.10	19	70	<.020	<.10	<.10	<.060
10/05/82	1.0	56	5.0	1.8	<.10	22	84	<.020	<.10	<.10	.060
04/22/83	1.1	33	7.2	1.5	<.10	15	50	<.020	<.10	<.10	.060

Table 6.--Chemical analyses of water from streams--Continued

Date of sample	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as NH_4)	Nitrogen, ammonia + organic dissolved (mg/L as N)	Phosphorus, total (mg/L as P)	Phosphorus, total (mg/L as PO_4)	Phosphorus, ortho, total (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as FE)	Carbon, organic total (mg/L as C)
			402226122170501 Tributary at Holiday Ranch							
05/10/82	0.140	0.18	0.87	0.030	0.09	0.030	0.010	30	74	3.5
10/08/82	.060	.08	.80	.080	.25	.040	.040	30	83	2.7
04/19/83	.080	.10	.40	.090	.28	.030	.010	40	85	2.5
			402242122174901 Ditch No. 1 at Clarks Ranch							
05/20/82	.060	.08	.73	.080	.25	.050	.030	20	180	4.9
10/05/82	.110	.14	.80	.190	.58	.150	.010	30	12	7.8
04/22/83	<.060	---	.90	.100	.31	.040	.050	20	150	2.2
			402249122174301 Ditch No. 2 at Clarks Ranch							
05/20/82	.090	.12	.55	.120	.37	.050	.040	30	82	5.3
10/05/82	<.060	.08	.40	.050	.15	.030	.020	30	27	---
04/22/83	<.060	---	.60	.080	.25	.020	.040	20	30	1.2
			402206122184901 Hooker Creek at Draper Road							
10/07/82	.070	.09	.70	.030	.09	.010	<.010	50	16	2.2
04/25/83	.310	.40	1.9	.060	.16	.020	.020	40	120	---
			402229122191801 Cottonwood Creek below South Fork							
05/14/82	.080	.10	.70	.160	.49	.140	.140	30	13	1.2
10/06/82	.080	.10	.30	.010	.03	<.010	<.010	40	10	1.3
04/22/83	<.060	---	.60	.080	.25	.020	.050	10	64	1.1
			402225122193901 Tributary below South Fork confluence, left bank							
05/20/82	.080	.10	.91	.080	.25	.040	.020	20	630	3.2
10/05/82	.060	.08	.60	.040	.12	<.010	.010	30	800	2.7
04/22/83	.060	.08	.70	.510	1.6	.450	.460	<10	140	1.6

Table 6.--Chemical analyses of water from streams--Continued

Date of sample	Time	Streamflow, instantaneous (ft^3/s)	Specific conductance (μS)	pH (standard units)	Temperature (°C)	Oxygen, dissolved (mg/L)	Hardness (mg/L as $CaCO_3$)	Hardness, noncarbonate (mg/L $CaCO_3$)	Calcium, dissolved (mg/L as C)	Magnesium, dissolved (mg/L as MG)	Sodium, dissolved (mg/L as NA)	Percent sodium
11375815 Cottonwood Creek above South Fork, near Cottonwood												
05/13/82	1600	429	236	8.3	20.5	9.6	98	2	21	11	5.8	11
10/07/82	1330	31	294	8.3	17.0	11.4	130	8	27	16	10	14
04/20/83	1510	1,230	222	8.1	14.5	9.7	90	9	20	9.7	6.4	13
402234122215501 Tributary at Moore Ranch												
04/19/83	1415	.96	98	7.3	16.5	9.6	33	0	7.1	3.8	5.6	26
402227122230901 Cottonwood Creek at Joanne Road												
05/12/82	1315	423	223	8.2	18.0	9.6	95	0	20	11	5.5	11
10/06/82	1200	28	285	8.3	16.5	10.3	130	8	27	16	11	15
04/20/83	1315	1,250	236	8.1	13.5	10.5	90	11	20	9.7	6.5	13
402203122242901 Little Dry Creek at Peterson Ranch												
04/25/83	1330	13	142	7.2	18.0	13.4	44	3	8.5	5.6	5.0	19
402249122251601 Dry Creek below Steele Ranch												
05/12/82	1310	2.8	70	7.3	21.5	8.9	26	0	5.8	2.8	4.8	28
04/19/83	1330	12	74	7.3	17.0	9.8	27	0	5.9	2.9	4.1	24
402232122254401 Cottonwood Creek at Steele Ranch												
05/13/82	1030	409	214	8.1	16.0	9.8	95	0	20	11	5.7	--
10/06/82	1000	27	298	8.0	14.5	9.2	140	6	28	16	11	15
04/20/83	1100	1,260	240	7.7	11.5	10.6	94	16	21	10	6.7	13
402239122261401 Antelope Creek at Meadowoak Road												
04/19/83	1245	1.3	80	7.9	18.0	10.6	32	0	7.3	3.3	4.1	21

Table 6.--Chemical analyses of water from streams--Continued

Date of sample	Potassium, dissolved (mg/L as K)	Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as CL)	Fluoride, dissolved (mg/L as F)	Silica, dissolved, (mg/L as SIO_2)	Solids, residue at 180°C dissolved (mg/L)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, NO_2+NO_3 total (mg/L as N)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)
11375815 Cottonwood Creek above South Fork, near Cottonwood											
05/13/82	1.0	96	7.0	2.9	0.10	20	135	0.020	0.10	0.10	0.160
10/07/82	1.2	125	9.0	11	.10	19	168	.020	.10	.10	.070
04/20/83	.9	81	19	2.7	<.10	19	119	<.020	<.10	<.10	<.060
402234122215501 Tributary at Moore Ranch											
04/19/83	1.1	---	3.8	1.7	<.10	16	50	<.020	<.10	<.10	.060
402227122230901 Cottonwood Creek at Joanne Road											
05/12/82	.9	98	7.0	3.0	<.10	20	142	<.020	<.10	<.10	<.060
10/06/82	1.3	125	9.0	12	.10	18	164	<.020	<.10	<.10	.070
04/20/83	1.0	79	20	3.1	<.10	18	120	.020	<.10	<.10	.070
402203122242901 Little Dry Creek at Peterson Ranch											
04/25/83	1.2	41	3.4	5.8	<.10	20	71	<.020	<.10	<.10	.370
402249122251601 Dry Creek below Steele Ranch											
05/12/82	.8	35	<5.0	1.2	<.10	18	58	<.020	<.10	<.10	<.060
04/19/83	.8	40	2.8	1.1	<.10	16	43	---	---	<.10	---
402232122254401 Cottonwood Creek at Steele Ranch											
05/13/82	<.1	100	7.0	3.0	<.10	20	138	<.020	<.10	<.10	.130
10/06/82	1.2	130	9.0	12	.10	17	162	<.020	<.10	<.10	.070
04/20/83	1.0	78	22	4.0	<.10	18	125	<.020	<.10	<.10	.060
402239122261401 Antelope Creek at Meadowoak Road											
04/19/83	1.1	40	2.5	1.5	<.10	19	51	.020	<.10	<.10	.060

Table 6.--Chemical analyses of water from streams--Continued

Date of sample	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as NH_4)	Nitrogen, ammonia + organic dissolved (mg/L as N)	Phosphorus, total (mg/L as P)	Phosphorus, total (mg/L as PO_4)	Phosphorus, ortho, total (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as FE)	Carbon, organic total (mg/L as C)
			11375815 Cottonwood Creek above South Fork, near Cottonwood							
05/13/82	0.170	0.22	0.70	0.020	0.06	0.020	0.020	20	9	0.6
10/07/82	.070	.09	.70	.010	.03	.010	.010	30	3	1.3
04/20/83	<.060	---	.60	.130	.40	.040	.040	10	33	2.7
			402234122215501 Tributary at Moore Ranch							
04/19/83	.060	.08	.50	<.010	---	.010	.010	<10	40	5.5
			402227122230901 Cottonwood Creek at Joanne Road							
05/12/82	.070	.09	.70	.030	.09	.020	.020	30	13	1.0
10/06/82	.080	.10	.60	.010	.03	<.010	<.010	20	4	1.9
04/20/83	<.060	---	.30	.120	.37	.030	.060	10	16	2.2
			402203122242901 Little Dry Creek at Peterson Ranch							
04/25/83	.190	.24	.70	.060	.18	.030	.040	<10	54	---
			402249122251601 Dry Creek below Steele Ranch							
05/12/82	.070	.09	.51	<.010	---	.020	.020	20	16	1.0
04/19/83	.070	.09	.20	---	---	---	.020	10	56	1.2
			402232122254401 Cottonwood Creek at Steele Ranch							
05/13/82	.170	.22	.70	.030	.09	.020	.020	30	<9	.4
10/06/82	.060	.08	.30	.010	.03	<.010	<.010	20	<3	1.2
04/20/83	<.060	---	.40	.120	.37	.020	.050	10	22	2.4
			402239122261401 Antelope Creek at Meadowoak Road							
04/19/83	.060	.08	.30	.060	.18	.010	.010	<10	31	1.6

Table 6.--Chemical analyses of water from streams--Continued

Date of sample	Time	Streamflow, instantaneous (ft^3/s)	Specific conductance (µS)	pH (standard units)	Temperature (°C)	Oxygen, dissolved (mg/L)	Hardness (mg/L as $CaCO_3$)	Hardness, noncarbonate (mg/L $CaCO_3$)	Calcium, dissolved (mg/L as C)	Magnesium, dissolved (mg/L as MG)	Sodium, dissolved (mg/L as NA)	Percent sodium
				11375810 Cottonwood Creek near Olinda								
05/12/82	1020	436	179	8.1	14.5	9.6	98	0	21	11	5.7	11
10/06/82	0830	25	300	8.4	14.5	9.4	140	9	28	16	11	15
04/19/83	1010	1,270	192	8.0	12.0	10.2	91	81	20	10	6.2	13
				402306122292201 Dutch Gulch at Gas Point Road								
05/12/82	0900	.52	127	7.3	17.0	8.1	51	0	9.1	6.9	8.0	25
04/19/83	0900	2.3	10	7.2	14.5	9.0	40	0	7.5	5.2	6.1	24
				11375900 South Fork Cottonwood Creek at Evergreen Road, near Cottonwood								
05/19/82	1250	266	282	8.1	19.5	9.1	110	5	30	9.7	10	16
10/07/82	1500	5.4	338	8.3	18.5	12.0	140	33	35	12	15	19
04/25/83	1420	---	402	8.1	12.5	10.6	140	11	35	13	12	16
				402103122211001 South Fork Cottonwood Creek near Bowman Store								
05/19/82	1020	263	294	8.1	15.0	9.3	110	5	30	9.7	9.9	16
10/07/82	1215	7.0	350	8.0	16.5	10.6	140	37	36	13	16	19
04/26/83	1320	689	393	8.1	12.0	10.5	140	21	35	13	12	16
				402108122205901 Tributary at Bowman Store								
04/25/83	1415	.26	81	7.3	20.5	8.8	25	0	5.6	2.7	4.4	26
				402020122222001 Pine Creek at Bowman Road								
04/25/83	1500	3.1	72	7.1	19.0	9.6	26	1	4.9	3.3	3.1	20
				402016122224201 South Fork Cottonwood Creek above Pine Creek								
05/19/82	0845	264	242	7.8	14.5	9.3	110	15	30	9.7	9.9	16
10/07/82	1100	7.4	350	8.4	15.0	11.8	140	32	36	13	17	20
04/26/83	1215	685	383	8.1	12.0	10.0	140	21	35	13	12	16

Table 6.--Chemical analyses of water from streams--Continued

Date of sample	Potassium, dissolved (mg/L as K)	Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as CL)	Fluoride, dissolved (mg/L as F)	Silica, dissolved, (mg/L as SIO_2)	Solids, residue at 180°C dissolved (mg/L)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, NO_2+NO_3 total (mg/L as N)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)
				11375810 Cottonwood Creek near Olinda							
05/12/82	0.9	98	6.0	3.0	<0.10	20	129	<0.020	<0.10	<0.10	<0.060
10/06/82	1.2	127	9.0	12	.10	18	167	<.020	<.10	<.10	.080
04/19/83	1.0	10	15	2.7	<.10	19	117	<.020	<.10	<.10	.060
				402306122292201 Dutch Gulch at Gas Point Road							
05/12/82	.8	64	<5.0	1.9	<.10	26	98	<.020	<.10	<.10	<.060
04/19/83	.8	60	3.1	1.9	<.10	24	66	.020	<.10	<.10	.080
				11375900 South Fork Cottonwood Creek at Evergreen Road, near Cottonwood							
05/19/82	1.1	110	18	7.1	.20	13	160	<.020	<.10	<.10	<.060
10/07/82	1.2	104	22	29	<.10	13	197	<.020	<.10	<.10	.070
04/25/83	.9	130	30	6.5	<.10	14	178	<.020	<.10	<.10	.360
				402103122211001 South Fork Cottonwood Creek near Bowman Store							
05/19/82	1.1	110	18	7.2	.20	13	137	<.020	<.10	<.10	<.060
10/07/82	1.2	107	22	32	.10	13	201	<.020	<.10	<.10	<.060
04/26/83	.8	120	31	6.4	.10	14	248	<.020	<.10	<.10	.380
				402108122205901 Tributary at Bowman Store							
04/25/83	1.4	36	6.0	3.6	<.10	12	48	.020	.20	.18	.460
				402020122222001 Pine Creek at Bowman Road							
04/25/83	1.0	25	2.8	1.4	<.10	15	43	<.020	.10	.12	.440
				402016122224201 South Fork Cottonwood Creek above Pine Creek							
05/19/82	.9	100	19	7.1	.20	13	105	<.020	<.10	<.10	<.060
10/07/82	1.2	111	21	34	.10	12	204	<.020	<.10	<.10	.060
04/26/83	.9	120	30	6.5	.10	14	191	<.020	<.10	<.10	.370

Table 6.--Chemical analyses of water from streams--Continued

Date of sample	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as NH_4)	Nitrogen, ammonia + organic dissolved (mg/L as N)	Phosphorus, total (mg/L as P)	Phosphorus, total (mg/L as PO_4)	Phosphorus, ortho, total (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as FE)	Carbon, organic total (mg/L as C)
11375810 Cottonwood Creek near Olinda										
05/12/82	0.090	0.12	0.54	<0.010	---	0.020	0.020	20	<9	0.7
10/06/82	.110	.14	.70	.020	0.06	<.010	<.010	30	6	1.6
04/19/83	.090	.12	.30	.070	.21	.020	.020	20	20	1.5
402306122292201 Dutch Gulch at Gas Point Road										
05/12/82	<.060	.08	.55	<.010	---	.020	.020	20	20	.9
04/19/83	.110	.14	.20	.040	.12	.010	.040	20	69	1.5
11375900 South Fork Cottonwood Creek at Evergreen Road, near Cottonwood										
05/19/82	<.060	.08	.44	<.020	---	.020	.020	490	<9	1.4
10/07/82	.060	.08	.60	.020	.06	<.010	<.010	90	7	1.0
04/25/83	.170	.22	.30	.060	.18	<.020	.020	50	11	2.5
402103122211001 South Fork Cottonwood Creek near Bowman Store										
05/19/82	.060	.08	.40	<.010	---	.010	.020	50	<9	1.3
10/07/82	<.060	.08	.40	<.010	---	<.010	<.010	100	<3	.8
04/26/83	.310	.40	.50	.060	.18	.020	.020	40	<3	---
402108122205901 Tributary at Bowman Store										
04/25/83	.190	.24	.90	.040	.12	.030	.030	<10	110	---
402020122222001 Pine Creek at Bowman Road										
04/25/83	.170	.22	.80	.070	.21	.040	.030	<10	30	---
402016122224201 South Fork Cottonwood Creek above Pine Creek										
05/19/82	.070	.09	.50	.030	.09	.020	.020	50	<9	1.3
10/07/82	.070	.09	.30	<.010	---	<.010	<.010	100	<3	1.7
04/26/83	.280	.36	.60	.080	.25	.030	.020	50	11	2.6

Table 6.--Chemical analyses of water from streams--Continued

Date of sample	Time	Stream-flow, instan-taneous (ft^3/s)	Spe-cific con-duct-ance (μS)	pH (stand-ard units)	Tem-pera-ture (°C)	Oxygen, dis-solved (mg/L)	Hard-ness (mg/L as $CaCO_3$)	Hard-ness, noncar-bonate (mg/L $CaCO_3$)	Calcium, dis-solved (mg/L as C)	Magne-sium, dis-solved (mg/L as MG)	Sodium, dis-solved (mg/L as NA)	Per-cent sodium
401953122245601 Tributary below Shelter Haven Court												
04/26/83	1100	0.79	84	6.8	0.0	9.8	26	0	5.1	3.2	4.5	26
401955122252201 South Fork Cottonwood Creek at Farquhar Road												
05/17/82	1215	286	308	8.2	19.5	8.6	120	8	31	9.7	10	16
10/07/82	1000	7.6	355	8.3	12.5	11.5	150	38	39	13	17	20
04/26/83	1000	660	297	8.1	9.5	10.8	140	19	34	13	12	16
11375870 South Fork Cottonwood Creek near Olinda												
05/18/82	0900	271	324	8.0	14.0	10.0	110	11	30	9.6	9.8	16
10/07/82	0830	8.1	360	8.2	11.0	10.3	150	35	40	13	17	19
04/26/83	0840	675	260	8.1	9.0	11.1	130	20	34	11	9.6	14

Table 6.--Chemical analyses of water from streams--Continued

Date of sample	Potassium, dissolved (mg/L as K)	Alkalinity field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as CL)	Fluoride, dissolved (mg/L as F)	Silica, dissolved, (mg/L as SIO_2)	Solids, residue at 180°C dissolved (mg/L)	Nitrogen, nitrite total (mg/L as N)	Nitrogen, NO_2+NO_3 total (mg/L as N)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)	Nitrogen, ammonia total (mg/L as N)
401953122245601 Tributary below Shelter Haven Court											
04/26/83	1.1	29	6.3	2.4	<0.10	19	63	<0.020	0.20	0.20	0.400
401955122252201 South Fork Cottonwood Creek at Farquhar Road											
05/17/82	.9	110	20	6.9	.10	13	153	<.020	<.10	<.10	<.060
10/07/82	1.2	113	21	35	<.10	11	214	<.020	<.10	<.10	.070
04/26/83	.8	120	29	6.4	<.10	13	175	<.020	<.10	<.10	.360
11375870 South Fork Cottonwood Creek near Olinda											
05/18/82	1.0	104	18	7.1	.20	13	163	.020	---	.10	---
10/07/82	1.4	119	23	36	.10	12	211	<.020	<.10	<.10	.060
04/26/83	.8	110	24	5.6	<.10	12	157	<.020	<.10	<.10	.380

Table 6.--Chemical analyses of water from streams--Continued

Date of sample	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, ammonia dissolved (mg/L as NH_4)	Nitrogen, ammonia + organic dissolved (mg/L as N)	Phosphorus, total (mg/L as P)	Phosphorus, total (mg/L as PO_4)	Phosphorus, ortho, total (mg/L as P)	Phosphorus, ortho, dissolved (mg/L as P)	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as FE)	Carbon, organic total (mg/L as C)
401953122245601 Tributary below Shelter Haven Court										
04/26/83	0.180	0.23	0.60	0.040	0.12	0.020	0.170	<10	160	---
401955122252201 South Fork Cottonwood Creek at Fahquhar Road										
05/17/82	.080	.10	.63	.260	.80	.020	.020	120	10	1.4
10/07/82	.080	.10	.40	<.010	---	<.010	<.010	100	<3	.5
04/26/83	.180	.23	.20	.050	.15	.020	.020	50	21	2.4
11375870 South Fork Cottonwood Creek near Olinda										
05/18/82	.070	.09	.50	.020	.06	---	.020	50	10	---
10/07/82	.070	.09	.80	.010	.03	<.010	<.010	110	4	.7
04/26/83	.280	.36	.50	.060	.18	.020	.010	40	100	---

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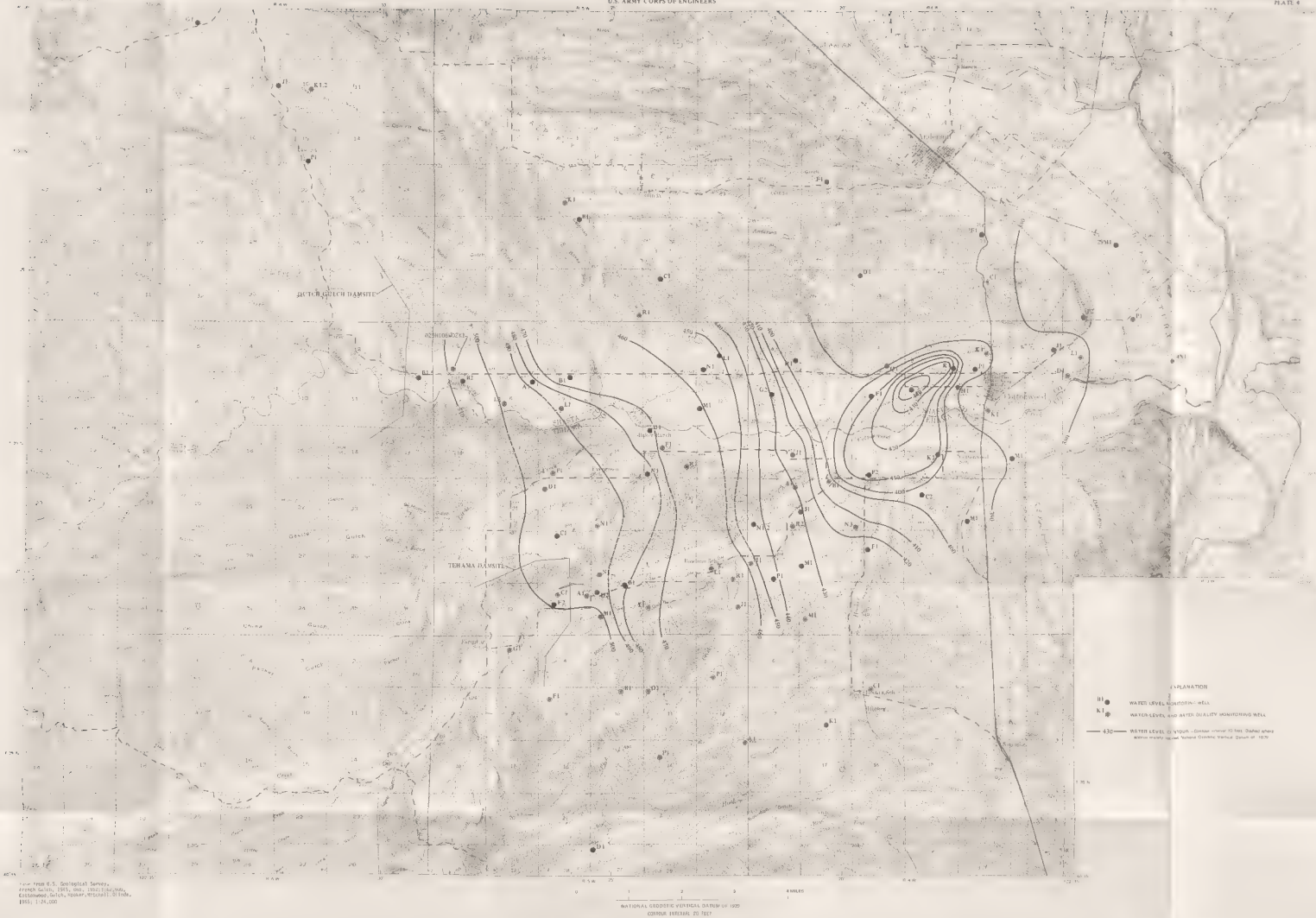
WATER-RESOURCES INVESTIGATIONS REPORT 84-4157
PLATE 4



MAP OF THE COTTONWOOD CREEK AREA, SHASTA AND TEHAMA COUNTIES, CALIFORNIA, SHOWING GROUND-WATER LEVELS, MARCH 1983

#21-4187

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WATER-RESOURCES INVESTIGATIONS REPORT 84-4155
PLATE

MAP OF THE COTTONWOOD CREEK AREA, SHASTA AND TEHAMA COUNTIES, CALIFORNIA, SHOWING GROUND-WATER LEVELS, SEPTEMBER 1982

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GEOLOGICAL SURVEY

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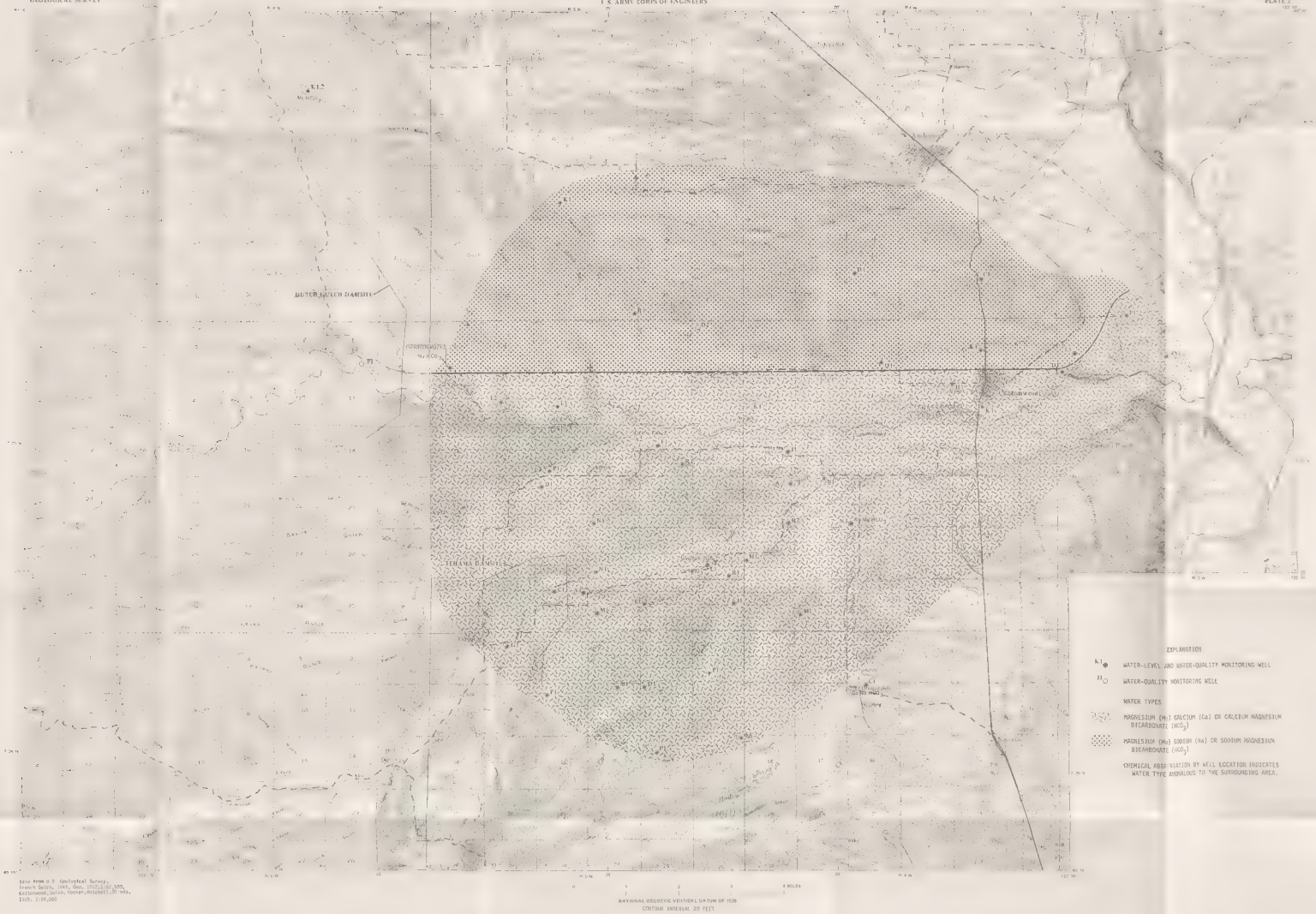
WATER-RESOURCES INVESTIGATIONS REPORT 84-4187
PLATE 2



MAP OF THE COTTONWOOD CREEK AREA, SHASTA AND TEHAMA COUNTIES, CALIFORNIA, SHOWING AREAL DISTRIBUTION OF GROUND-WATER TYPES, OCTOBER 1982

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WATER-RESOURCES INVESTIGATIONS REPORT 84-4157
PLATE 1

Base from U.S. Geological Survey,
French Gulch, 1945, Dno. 1952;1:62,500,
Cottonwood,Gulch,Hooker,Mitchell,Olinda,
1965; 1:24,000

0 1 2 3 4 MILES

NATIONAL GEODETIC VERTICAL DATUM OF 1929
CONTOUR INTERVAL 20 FEET

MAP OF THE COTTONWOOD CREEK AREA, SHASTA AND TEHAMA COUNTIES, CALIFORNIA, SHOWING LOCATION OF MONITORING SITES

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